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2. **NAME OF AGENCY:**

   BOARD OF STATE EXAMINERS OF PLUMBERS AND GAS FITTERS

3. **THIS DOCUMENT IS REPRINTED FROM THE CODE OF MASSACHUSETTS REGULATIONS AND CONTAINS THE FOLLOWING:**

   ALL REGULATIONS OF THE BOARD

UNDER THE PROVISIONS OF MASSACHUSETTS GENERAL LAWS, CHAPTER 30A, SECTION 6 AND CHAPTER 233, SECTION 75 THIS DOCUMENT MAY BE USED AS EVIDENCE OF THE ORIGINAL DOCUMENTS ON FILE WITH THE STATE SECRETARY.

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A TRUE COPY, ATTEST:
Michael Joseph Connolly
MICHAEL JOSEPH CONNOLLY,
SECRETARY OF STATE

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Table of Contents

Page

(248 CMR 1.00: RESERVED) 5

248 CMR 2.00: UNIFORM STATE PLUMBING CODE 15

Section 2.01: Authorization, Penalty, Sections Declared Independent and Limit of Jurisdiction 15
Section 2.02: Basic Principles 16
Section 2.03: Definitions 18
Section 2.04: Scope and Application 28
Section 2.05: General Regulations 32
Section 2.06: Materials 35
Section 2.07: Joints and Connections 55
Section 2.08: Traps and Cleanouts 58
Section 2.09: Interceptors, Separators and Backwater Valves 62
Section 2.10: Plumbing Fixtures 64
Section 2.11: Hangers and Supports 73
Section 2.12: Indirect Waste Piping 74
Section 2.13: Piping and Treatment of Special Wastes 77
Section 2.14: Water Supply and Distribution 82
Section 2.15: Sanitary Drainage System 98
Section 2.16: Vents and Venting 104
Section 2.17: Storm Drains 113
Section 2.18: Hospital Fixtures 115
Section 2.19: Plumbing in Mobile Homes 123
Section 2.20: Swimming Pools 124
Section 2.21: Boiler Blow-off Tank 125
Section 2.22: Chapter 142 126
Section 2.23: Figures 128

(248 CMR 3.00: RESERVED) 149

MASSACHUSETTS FUEL GAS CODE

248 CMR 4:00: GENERAL RULES 149

Section 4.01: Penalty for Failure to Comply with Provisions of Code 149
Section 4.02: General Rules of the Board 149

INTRODUCTION AND MASSACHUSETTS MODIFICATIONS
Pages numbered internally 1 - 23

248 CMR 5.00: NATIONAL FUEL GAS CODE - NFPA 54, 1984/ANSI Z 223.1, 1984
Pages numbered internally vi - ix and 1 - 215

248 CMR 6.00: LIQUIFIED PETROLEUM GASES - ANSI/NFPA 58, 1983
Pages numbered internally 58-4 - 58-192

248 CMR 7.00: GAS UTILIZATION EQUIPMENT IN LARGE BOILERS
Pages numbered internally 1 - 28

(PAGES 3 AND 4 ARE RESERVED FOR FUTURE USE.)

(248 CMR 1.00: RESERVED)*

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* Editors' Note: See 801 CMR 1.00: Standard Adjudicatory Rules of Practice and Procedure promulgated by the Executive Office for Administration and Finance published in Massachusetts Register #138 and effective 3/29/79.

(PAGES 6 THROUGH 14 ARE RESERVED FOR FUTURE USE.)

248 CMR 2.00: UNIFORM STATE PLUMBING CODE

Section

2.01: Authorization, Penalty, Sections Declared Independent and Limit of Jurisdiction
2.02: Basic Principles
2.03: Definitions
    Definition of Cross Connection
    Definition of Relief Vent
2.04: Scope and Application
2.05: General Regulations
2.06: Materials
    Table 1. Stadards for Approved Plumbing Materials and Equipment
    Copper
    PVC Plastic Pipe and Fittings
2.07: Joints and Connections
2.08: Traps and Cleanouts
2.09: Interceptors, Separators and Backwater Valves
2.10: Plumbing Fixtures
    Food, Waste, Grinder Units
    Table 2. Plumbing Fixtures Required for Schools
2.11: Hangers and Supports
2.12: Indirect Waste Piping
2.13: Piping and Treatment of Special Wastes
2.14: Water Supply and Distribution
    Installing the Building Water Distribution System
    Water Connections to Heating Boilers
    Hot Water Supply System
2.15: Sanitary Drainage System
    Maximum Load Tables
2.16: Vents and Venting
    Stack Venting
    Future Venting
2.17: Storm Drains
2.18: Hospital Fixtures
    Special Elevations
    Water Supply
2.19: Plumbing in Mobile Homes
2.20: Swimming Pools
2.21: Boiler Blow-off Tank
2.22: Chapter 142
2.23: Figures

2.01: Authorization, Penalty, Sections Declared Independent and Limit of Jurisdiction

(1) Authorization. This Code was authorized, formulated and adopted under Section 13 of Chapter 142 of the General Laws, which now reads:

> In all cities and towns, the examiners, subject to the approval of the Massachusetts Department of Environmental Quality Engineering, shall make and from time to time in like manner, alter, amend, and repeal rules and regulations relative to the construction, alteration, repair and inspection of plumbing in such cities and towns, which rules and regulations shall be reasonable, uniform, and based on generally accepted standards of plumbing practice; provided, however, that the application of such rules and regulations may be varied by the examiners in a particular city or town upon petition of the board of health or health department thereof. The examiners shall adopt a regulation requiring all cities and towns to use a uniform application for a permit to perform plumbing work.

(2) Penalty. Every person engaged in the business of a master plumber or working as a journeyman or as an apprentice not lawfully

2.01: continued

registered or licensed as required by Chapter 142 of the General Laws, every person engaging in or working at the business of plumbing in a city or town, when forbidden to do so under Chapter 142 of the General Laws, every master plumber who engages or employs any person to work as a journeyman or as an apprentice who has not been so registered or licensed, and any person violating any provision of this Code shall be punished by a fine not exceeding one hundred dollars.

(3) Sections Declared Independent. Each Section of this Code and every part of each Section is hereby declared to be an independent Section and part of Section and the holding of any Section or part of Section to be void and ineffective for any cause, shall not be deemed to affect any other Section or part of Sections.

(4) Limit of Jurisdiction. Nothing in this Code shall be construed as applying to refrigerating, heating, cooling, ventilating or sprinkler fire protection systems beyond the point where connection is made with the potable water distributing system, or with sanitary, storm water or special wastes drainage systems. Such connections shall be made subject to the inspection and approval of the Inspector of Plumbing.

2.02: Basic Principles

Founding of Principles. This Code is founded upon certain principles of environmental sanitation and safety through properly designed, acceptably installed, and adequately maintained plumbing systems.

Some of the details of plumbing construction may vary but the basic sanitary and safety principles desirable and necessary to protect the health of people are the same everywhere. As interpretations may be required, and as unforeseen situations arise which are not specifically covered in this Code, the final interpretation shall be made by the Board of State Examiners of Plumbers and Gas Fitters.

The following principles shall comply with all Articles of the State Sanitary Code and Titles of the Environmental Code.

(1) Principle No. 1 -- All Occupied Premises Must Have Potable Water. All premises intended for human habitation, occupancy, or use must be provided with a supply of potable water. Such a water supply shall not be connected with unsafe or questionable water sources, nor shall it be subject to the hazards of backflow, backpressure or back-siphonage.

(2) Principle No. 2 -- Adequate Water Required. Plumbing fixtures, devices, and appurtenances must be supplied with water in sufficient volume and at pressures adequate to enable them to function properly and without undue noise under normal conditions of use.

(3) Principle No. 3 -- Hot Water Required. Hot water must be supplied to all plumbing fixtures which normally need or require hot water for their proper use and fucntion.

(4) Principle No. 4 -- Water Conservation. Plumbing must be designed and adjusted to use the minimum quantity of water consistent with proper performance and cleaning.

(5) Principle No. 5 -- Dangers of Explosion or Overheating. Devices and appliances for heating and storing water must be so designed and installed as to guard against dangers from explosion or overheating.

(6) Principle No. 6 -- Required Plumbing Fixtures. Each family dwelling must have at least one water closet, one lavatory, one kitchen-

2.02: continued

type sink, one bathtub or shower and laundry tray or connections for a washing machine, to meet the basic requirements of sanitation and personal hygiene. (In multiple dwellings, housing families, one laundry tray or washing machine for every ten apartments, or fraction thereof, shall be acceptable as meeting laundry facilites in this Principle.) One laundry tray or washing machine for every twenty apartments or fraction thereof, shall be acceptable in housing for the elderly.

All other structures for habitation must be equipped with sufficient sanitary facilites. Plumbing fixtures must be made of durable, smooth, nonabsorbent and corrosion resistant material and must be free from concealed fouling surfaces.

(7) Principle No. 7 -- Drainage System of Adequate Size. The drainage system must be designed, constructed, and maintained to guard against fouling, deposit of solids, and clogging, and with adequate cleanouts so arranged that the pipes may be readily cleaned.

(8) Principle No. 8 -- Durable Materials and Good Workmanship. The piping of the plumbing system must be of durable material, free from defective workmanship and so designed and constructed as to give satisfactory service for its reasonable expected life.

(9) Principle No. 9 -- Liquid Sealed Traps Required. Each fixture directly connected to the drainage system must be equipped with a liquid-seal trap.

(10) Principle No. 10 -- Trap Seals Shall Be Protected. The drainage system must be designed to provide an adequate circulation of air in all pipes with no danger of siphonage, aspiration, or forcing of trap seals under conditions of ordinary use.

(11) Principle No. 11 -- Exhaust Foul Air to Outside. Each vent terminal must extend to the outer air at the roof line and be so installed as to minimize the possibilities of clogging and the return of foul air to the building.

(12) Principle No. 12 -- Test the Plumbing System. The plumbing system must be subjected to such tests as will effectively disclose all leaks and defects in the work or the materials.

(13) Principle No. 13 -- Exclude Certain Substances from the Plumbing System. No substance which will clog or accentuate clogging of pipes, produce explosive mixtures, destroy the pipes or their joints, or intefere unduly with the sewage disposal process shall be allowed to enter the building drainage system.

(14) Principle No. 14 -- Prevent Contamination. Proper protection shall be provided to prevent contamination of food, water, sterile goods, and similar materials by backflow of sewage. When necessary, the fixture, device, or appliance shall be connected indirectly with the building drainage system.

(15) Principle No. 15 -- Light and Ventilation. No water closet or similar fixture shall be located in a room or compartment which is not properly lighted and ventilated.

(16) Principle No. 16 -- Individual Sewage Disposal Systems. If water closets or other plumbing fixtures are installed in buildings where there is no sewer within a reasonable distance, suitable provision shall be made for disposing of the sewage by some accepted method of sewage treatment and disposal.

(17) Principle No. 17 -- Prevent Sewer Flooding. Where a plumbing

2.02: continued

draninage system is subject to back flow of sewage from the public sewer suitable provision shall be made to prevent its overflow in the building.

(18) Principle No. 18 -- Proper Maintenance. Plumbing systems shall be maintained in a safe and serviceable condition from the standpoint of both mechanics and health.

(19) Principle No. 19 -- Fixtures Shall Be Accessible. All plumbing fixtures shall be so installed with regard to spacing as to be accessible for their intended use and cleansing.

(20) Principle No. 20 -- Structural Safety. Plumbing shall be installed with due regard to preservation of the strength of structural members and prevention of damage to walls and other surfaces through fixture usage.

(21) Principle No. 21 -- Protect Ground and Surface Water. Sewage or other waste must not be discharged into surface or subsurface water unless it has first been subjected to some acceptable form of treatment.

(22) Principle No. 22 -- Piping and Treatment of Special Wastes. All materials that could become detrimental to the health and welfare of the general public, that enter the sanitary system of any building, shall be carried within special piping systems and either collected and disposed of or treated prior to entering the sanitary drainage system in accordance with the requirements of the authorities having jurisdiction.

2.03: Definitions

(1) General. For the purpose of this Code, the following terms shall have the meaning indicated in this chaper. No attempt is made to define ordinary words which are used in accordance with their established dictionary meaning except where it is necessary to define their meaning as used in this Code to avoid misunderstanding.

(2) Definition of Terms.

Accessible. Accessible means having access thereto but which first may require the removal of an access panel, door or similar obstruction. "Readily accessible" means direct access without the necessity of removing or moving any panel, door or similar obstruction.

Administrative Authority. The Inspector of Plumbing authorized by Chapter 142 of the General Laws to administer and enforce the provisions of the plumbing code as adopted or amended, by the Board of State Examiners of Plumbers and Gas Fitters.

Air Break (Drainage System). A piping arrangement in which a drain from a fixture, appliance, or device discharges indirectly into a fixture, receptacle, or interceptor at a point below the flood level rim of the receptacle.

Air Gap (Drainage System). The unobstructed vertical distance through the free atmosphere bewteen the outlet of waste pipe and the flood level rim of the receptacle into which it is discharging.

Air Gap (Water Distribution System). The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank, plumbing fixture or other device and the flood level rim of the receptacle.

Alkalinity. The measure of its capacity to neutralize acids. The qual-

2.03: continued

ity or state of being alkaline. Containing more alkali than normal. Having a pH factor of more than 7. The opposite of acidity.

Anti-Siphon Vacuum Breaker--Non-Pressure Type (Back-Siphonage Preventer). A device or means to prevent back-siphonage. Not to be used under continuous pressure.

Anti-Siphon Vacuum Breaker--Pressure Type (Back-Siphonage Preventer). A device or means to prevent back-siphonage. Designed to be used under continuous pressure.

Approved. Accepted or acceptable under an applicable specification stated or cited in this Code, or accepted as suitable for the proposed use under procedures and powers of the Board of State Examiners of Plumbers.

Area Drain. A receptacle designed to collect surface or storm water from an open area.

Backflow. The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source or sources other than its intended source. Back-siphonage is one type of backflow.

Backflow Connection. Any arrangement whereby backflow can occur.

Backflow Preventor. A device or means to prevent backflow.

Backflow Preventor (Reduced Pressure Zone Type). An assembly of differential valves and check valves including an automatically opened spillage port to the atmosphere. Gauges must be installed where pressure reduction is mandatory.

Back-Pressure. Pressure created by mechanical means or other means, causing water, liquids or other substances to flow, or move, in a reverse or opposite direction than intended.

Back-Siphonage. The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel or other sources into a water supply pipe due to a negative pressure in such pipe.

Barometric Loop. A vertical loop of pipe, rising to a height sufficient to prevent back-siphonage from occurring in the potable water supply pipe. (Approximately 35 feet, depending on the weight of the atmosphere.)

Battery of Fixtures. Any group of two or more similar fixtures, that are adjacent, which discharge into a common horizontal waste or soil branch.

Battery Waste & Vent System. See Combination Waste & Vent System.

Board. State Board of Examiners of Plumbers and Gas Fitters.

Boiler Blow-Off. An outlet on a boiler to permit emptying or discharge of sediment.

Boiler Blow-Off Tank. A vessel designed to receive the discharge from a boiler blow-off outlet and to cool the discharge to a temperature of 130 degrees or less which permits its safe discharge to the drainage system.

Branch. Any part of the piping system other than a main, riser or stack.

2.03: continued

Branch Interval. A distance along a soil or waste stack corresponding in general to a story height, but in no case less than 8 feet, within which the horizontal branches from one floor or story of a building are connected to the stack.

Branch Vent. A vent connecting one of more individual vents with a vent stack or stack vent.

Building. A structure used for the housing, shelter, enclosure, or support of persons, animals or property.

Building Drain. Building main drain is the lowest horizontal piping of a drainage system that extends from the base of the main stack to a terminating point ten feet (10') outside the inner surface of the foundation wall, and is of sufficient size to receive the discharge from branch drains and/or stacks.

Building Drain -- Sanitary. A building drain which conveys the discharge of plumbing fixtures.

Building Drain -- Storm. A building drain which conveys storm water or other drainage allowed by this code.

Building Sewer -- Sanitary. The building sewer is the pipe which begins ten feet outside the inner face of the building wall and extends to a public sewer, septic tank, or other place of sewage disposal.

Building Sewer -- Combined. A building sewer which conveys both sewage and storm water or other drainage.

Building Sewer -- Storm. A building sewer whch conveys storm water or other drainage but no sewage.

Building Subdrain. That portion of a drainage system which cannot drain by gravity into the building sewer.

Cesspool. A cesspool is a covered pit with open-jointed lining in its bottom portions into which raw sewage is discharged, the liquid portion of the sewage being disposed of by seeping or leaching into the surrounding porous soil, and the solids or sludge being retained in the pit to undergo partial decomposition before occasional or intermittent removal.

Circuit Vent. A circuit vent is a branch vent that serves two or more floor-outlet fixtures that are battery wasted. Said vent extends from the top of the horizontal soil and/or waste branch in front of the last fixture waste and connects to a vent stack adjacent to the upstream end of the horizontal branch.

Code. These regulations, subsequent amendments thereto, or any emergency rule or regulation which the State Board of Examiners having jurisdiction may lawfully adopt.

Combination Fixture. A fixture combining one sink and laundry tray or a two or three compartment sink or laundry tray in one unit.

Combination Waste and Vent System. A combination waste and vent system is a specially designed system of waste piping embodying the horizontal wet venting of one or more plumbing fixtures or floor drains by means of a common waste and vent pipe adequately sized to provide free movement of air above the flow line of the drain.

Common Vent. A vent connecting at the junction of two fixture drains and serving as a vent for both fixture in a verticle position.

2.03: continued

Conductor. A pipe inside the building which conveys storm water from the roof to a storm or combined building drain or sewer.

Continuous Vent. A vertical vent that is a continuation of the vertical drain to which it connects.

Critical Level. The critical level is the minimum elevation that a backflow prevention device or anti-siphon vacuum breaker is installed, in the potable water supply piping, above the flood level rim of a fixture or receptacle it is to serve.

Cross Connection. Any physical connection or arrangement between two otherwise separate systems, one of which contains potable water and the other either water of unknown or questionable safety or steam, gas, or chemical whereby there may be a flow from one system to the other, the direction of flow depending on the pressure differential between the two systems. (See Back-flow and Back-Siphonage.)

DNA - (Deoxyribonucleic Acid). An essential component of all living matter and a basic material in the chromosomes of the cell nucleus. DNA transmits the heredity pattern.

Dead End. A branch leading from a soil, waste, or vent pipe, building drain, or building sewer, and terminating at a developed length of 2 feet or more by means of a plug, cap or other closed fitting.

Developed Length. The length of a pipeline measured along the center line of the pipe or fittings.

Diameter. The nominal diameter as designated commercially.

Double Offset. Two changes of direction installed in succession or series in a continuous pipe.

Domestic Sewage. The waterborne wastes derived from ordinary living processes.

Drain. A Drain is a horizontal pipe which carries waste water or waterborne waste in a building drainage system.

Drainage System. Includes all the piping, within public or private premises, which conveys sewage, rain water, or other liquid wastes to a legal point of disposal. It does not include the mains of a public sewer system or private or public sewage treatment or disposal plant.

Drainage System, Building Gravity. A drainage system which drains by gravity into the building sewer.

Dual Vent. (See Common Vent)

Durham System. A term used to describe soil or waste systems where all piping is of threaded pipe, using recessed drainage fittings to correspond to the types of piping.

Dwelling -- Single. A room or group of rooms, forming a single habitable unit that is an independent building enclosed within its own exterior walls, roof and foundation, with facilities which are used, or intended to be used, for sleeping, living, cooking and eating; and whose sewer connection and water supply are within its own premise separate from and completely independent of any other dwelling.

Dwelling -- Multiple. Two or more single dwellings that are not independent buildings and that do share a common exterior of walls, roof

2.03: continued

and foundation and a common sewer connection and water supply within its own premise.

Effective Opening. The minimum cross sectional area at the point of water supply discharge, measured or expressed in terms of (1) diameter of a circle, or (2) if the opening is not circular, the diameter of a circle of equivalent cross sectional area.

Existing Work. A plumbing system or any part thereof installed prior to the effective date of this Code.

Fermentation. The breakdown of complex molecules in organic compounds, caused by the influence of a ferment, such as bacteria cause milk to curdle by fermentation.

Fire Line. A system of pipes and equipment used exclusively to supply water for extinguishing fires.

Fixture Branch. A pipe connecting several fixtures.

Fixture Drain. The drain from the trap of a fixture to the junction of that drain with any other drain pipe.

Fixture Supply. The water supply pipe connecting a fixture to a branch water supply pipe or directly to a main water supply pipe.

Fixture Unit. The fixture unit is the rate of discharge through a plumbing fixture of 7 1/2 gallons per minute. This is termed one fixture unit.

Flood Level Rim. The edge of the receptacle from which water overflows.

Flooded. When the liquid in a fixture or receptacle rises to the flood level rim.

Flow Pressure. The pressure in the water supply pipe at the faucet or water outlet while the faucet or water outlet is wide open and flowing.

Flush Valve. A device located at the bottom of a tank for flushing water closets and similar fixtures.

Flushometer Valve. A device which discharges a predetermined quantity of water to fixtures for flushing purposes and is closed by direct water pressure.

Generally Accepted Standard. A specification, code, rule, guide, or procedure in the field or construction or related thereto, recognized and accepted as authoritative.

Genetic. The branch of biology that deals with heredity and variations of organisms.

Grade. The fall (slope) of a line of pipe in reference to a horizontal plane. In drainage it is usually expressed as the fall in a fraction of an inch per foot length of pipe.

Grease Interceptor. (See Interceptor)

Grease Trap. (See Interceptor)

Hangers. (See Supports)

2.03: continued

Horizontal Branch Drain. A drain branch pipe extending laterally from a soil or waste stack or building drain, with or without vertical sections or branches, which receives the discharge from one or more fixture drains and conducts it to the soil or waste stack or to the building drain.

Horizontal Pipe. Any pipe or fitting which makes an angle of less than 45° with the horizontal.

Hot Water. Water at a temperature of not less than 120°F.

Individual Sewage Disposal System. A system for disposal or treatment of domestic sewage by means of a septic tank or sewage treatment plant designed for use apart from a public sewer to serve a single establishment or building where public sewer is not available.

Indirect Waste Pipe. A waste pipe which does not connect directly with the drainage system, but which discharges into the drainage system through an air break or air gap into a trap, fixture, receptacle or interceptor, which is properly wasted and vented.

Individual Vent. A pipe installed to vent a fixture drain. It connects with the vent system above the fixture served or terminates at a point above the roof level.

Individual Water Supply. A supply other than an approved public water supply which serves one or more families.

Industrial Waste Water. Water that has been contaminated with byproducts of industrial manufacturing processess.

Industrial Wastes. Liquid wastes resulting from the processes employed in industrial and commercial establishments.

Insanitary. Contrary to sanitary principles; injurious to health.

Inspector. Shall mean Inspector of Plumbing (See Admin. Authority).

Interceptor. A device designed and installed so as to separate and retain deleterious, hazardous, or undesirable matter from normal wastes while permitting normal sewage or liquid wastes to discharge into the drainage system by gravity.

Installed. Altered, changed, or a new installation.

Investigator of Plumbers and Gas Fitters. A person employed by the Commonwealth of Massachusetts in the Board of State Examiners of Plumbers and Gas Fitters who shall, under the direction and supervision of the Executive Secretary to the Board, investigate plumbing and gasfitting complaints; plumber and gas fitter applications for licenses and permits; inspect plumbing and gasfitting work in state owned and occupied buildings; assist local plumbing and gas inspectors; assist in examination work for licensure of plumbers and gas fitters; interpret the provisions of Chapter 142 of the General Laws and the State Plumbing and Fuel Gas Codes; and perform other related duties by the Executive Secretary.

Irrigation System. A system of water distribution piping used to wet or moisten the land.

Journeyman. A person who himself does any work in plumbing subject to inspection under any law, ordinance, by-law, rule or regulation.

Leaching Well or Pit. A pit or receptacle having porous walls which

2.03: continued

permit the contents to seep into the ground.

Leader. An exterior drainage pipe for conveying storm water from roof or gutter drains.

Liquid Waste. The discharge from any fixture, appliance, area or appurtenance, which does not contain human or animal waste matter.

Load Factor. The percentage of the total connected fixture unit flow which is likely to occur at any point in the drainage system. It varies with the type of occupancy, the total flow unit above this point being considered, and with the probability factor of simultaneous use.

Loop Vent. A loop vent is a branch vent that serves two or more floor-outlet fixtures that are battery wasted. Said vent extends from the top of the horizontal soil and/or waste branch in front of the last fixture waste and connects to a vent stack or stack vent, adjacent to the down-stream end of the horizontal branch.

Main. The principal pipe artery to which branches may be connected.

May. The word "may" is a permissive term.

Master Plumber. A plumber having a regular place of business and who, by himself, journeyman or apprentices in his employ, performs plumbing work.

Materials (Plumbing). Materials shall mean all piping, tubing and fittings, drains and receptacles, interceptors and protectors, hangers and supports, covers and coverings, appliances and other devices and appurtenances used, or referred to, in the definitions of Plumbing, Plumbing Fixtures and Plumbing Systems.

Non-Potable Water. Water not safe for drinking, personal or culinary use.

Nuisance. Public nuisance as known at common law or in equity jurisprudence; whatever is dangerous to human life or detrimental to health; whatever building, structure or premise is not sufficiently ventilated, sewered, drained, cleaned or lighted, in reference to its intended or actual use; and whatever renders the air or human food or drink or water supply unwholesome.

Offset. A combination of elbows or bends which brings one section of the pipe out of line but into a line parallel with the other section.

pH. The negative logarithm of the hydrogen-ion concentration used in expressing both acidity and alkalinity on a scale whose values run from 0 to 14, with the lower number less than 7 indicating increasing acidity and numbers greater than 7 indicating increasing alkalinity. A reading of 7 would indicate a neutral pH condition.

Person. A natural person, his heirs, executors, administrators or assigns; and includes a firm, partnership, corporation, institution, association or group, its or their successors or assigns; and includes a city, town, county, or other governmental unit, owning or renting, leasing or controlling property, or carrying on an activity regulated by Chapter 142 M.G.L. and/or this Code.

Plan Examiner. A person employed by the Commonwealth of Massachusetts in the Board of State Examiners of Plumbers and Gas Fitters who shall, under the direction and supervision of the Executive Secretary to the Board, examine plans and specifications for compliance with

2.03: continued

State Plumbing and Fuel Gas Codes, and perform such duties as assigned by the Board through the Executive Secretary.

Plumber. Any person duly licensed by the Board of State Examiners of Plumbers as a Master or Journeyman Plumber, as required by Chapter 142 M.G.L.

Plumbing. Plumbing includes the work and/or practice, materials and fixtures used in the installation, removal, maintenance, extension and alteration of a plumbing system; of all piping, fixtures, fixed appliances and appurtenances in connection with any of the following: Sanitary drainage, storm drainage facilities, special wastes, the venting system and the public or private water-supply systems, within or adjacent to any building, structure, or conveyance; to their connection with any point of public disposal or other acceptable terminal within the property line.

Plumbing Fixture. Installed receptacles, devices, or appliances either supplied with water and/or receive and/or discharge liquids, or liquid-borne wastes, or both, with or without discharge into the drainage system with which they may be directly or indirectly connected.

Plumbing Inspector. (See Administrative Authority).

Plumbing System. The Plumbing System includes the water supply and distribution pipes; plumbing fixtures and traps; soil, waste, and vent pipes; building sanitary and storm drains including their respective connections, devices, and appurtenances to their connection with any point of public disposal or other acceptable terminal within the property line.

Potable Water. Water free from impurities present in amounts sufficient to cause disease or harmful physiological effects. Its bacteriological and chemical quality shall conform to the requirements of the regulations of the Massachusetts Department of Environmental Quality Engineering.

Private or Private Use. In the classification of plumbing fixtures, private applies to fixtures in residences and apartments and to fixtures in private bathroom of hotels as well as similar installations in other buildings where the fixtures are intended for the use of a family or an individual.

Private Sewer. A sewer, serving two or more buildings, privately owned, and not directly controlled by public authority.

Public or Public Use. In the classification of plumbing fixtures, public applies to every fixture not defined under Private Use, and public use applies to every fixture accessible to the public.

Public Sewer. A common sewer directly controlled by public authority.

Public Water Main. A water supply pipe for public use controlled by public authority.

Receptor. A fixture or device which receives the discharge from indirect waste pipes.

Relief Vent. A vent so planned as to permit additional circulation of air between drainage and vent systems.

Return Offset. A double offset installed so as to return the pipe to its original alignment.

2.03: continued

Rim. An unobstructed open edge of a fixture.

Riser. A water supply pipe which extends vertically one full story or more to convey water to branches or to a group of fixtures.

Roof Drain. A drain installed to receive water collecting on the surface of a roof and to discharge it into a leader or a conductor.

Roughing-In. The installation of all parts of the plumbing system which can be completed prior to the installation of fixtures. This includes drainage, water supply, vent piping and the necessary fixture supports, or any fixtures that are built into the structure.

Sand Trap. See Interceptor.

Sanitary Sewer. A pipe which carries sewage and excludes storm, surface and ground water.

Seepage Well or Pit. A covered pit with open jointed lining through which the septic tank effluent it receives may seep or leach into the surrounding porous soil.

Separator. See Interceptor.

Septic Tank. A water tight receptacle which receives the discharge of sewage from a building sewer and is designed and constructed so as to permit the retention of scum and sludge, disgestion of the organic matter and discharge of the liquid portion to a leaching facility.

Sewage. Any liquid waste containing animal or vegetable matter in suspension or solution, and may include liquids containing chemicals in solution.

Sewage Ejectors. A device for moving sewage by entraining it on a high velocity steam, air or water jet.

Sewage Pump. A permanently installed mechanical device other than an ejector for removing sewage or liquid waste from a pump.

Shall. The word "shall" is a mandatory term.

Side Vent. A side vent is a vent connecting to the drain pipe through a fitting at an angle not greater than 45 degrees to the vertical.

Siphon Breaker. A siphon breaker is a valve device, or appurtenance, constructed and installed to prevent back flow in the plumbing system or any portion thereof. (See Back Flow and Back-Siphonage)

Size of Pipe and Tubing. (See Diameter)

Slope. (See Grade)

Soil Pipe. Any pipe which conveys the discharge of water closets, urinals or fixtures having similar functions with or without the discharge from other fixtures, to the building drain or building sewer.

Special Wastes. In no case shall corrosive liquids, spent acids, or other harmful chemicals which might destroy or injure a drain, sewer, soil or waste pipe, or which might create noxious or toxic fumes, or which interferes with sewage treatment processes, discharge into the plumbing system without being thoroughly diluted, neutralized, or treated by passing through a property constructed and acceptable diluting or neutralizing device. Such device shall be automatically

2.03: continued

provided with a sufficient intake of diluting water or neutralizing medium, so as to make its contents non-injurious before being discharged into the drainage system.

Special Wastes, Piping or Treatment. Wastes which require special treatment before entry into the normal plumbing system.

Special Waste Pipe. Pipes which convey special wastes.

Stack. A general term for any vertical line of soil, waste, vent or inside conductor piping which extends beyond at least one branch interval in height.

Stack Group. Stack group is a term applied to the location of fixtures in relation to the stack so that by means of proper fittings, vents may be reduced to a minimum.

Stack Vent. The extension of a soil or waste stack above the highest horizontal drain connected to the stack terminating at a point above the roof level.

Stack Venting. A method of venting a fixture or fixtures through the soil or waste stack.

Storm Drainage System. Storm drainage system is that system which is used for conveying rain water, surface water, condensate, cooling water, or similar liquid wastes, exclusive of sewage or industrial waste, to the storm sewer or other legal place of disposal.

Storm Sewer. A sewer used for conveying rain water, surface water, condensate, cooling water, or similar liquid wastes.

Subsoil Drain. A drain which collects subsurface or seepage water and conveys it to a place of disposal.

Sump. A tank or pit, which receives sewage or liquid waste, located below the normal grade of the gravity system and which must be emptied by mechanical means.

Sump Pump. A mechanical device other than ejector or bucket for removing liquid waste from a sump.

Supports -- Hangers -- Anchors. Devices for supporting and securing pipe, fixtures, and equipment, to walls, ceilings, floors or structural members.

Swimming Pool. Any structure, basin, chamber, or tank containing an artificial body of water for swimming, diving, or recreational bathing and having a depth of two feet or more at any point.

Trap. A fitting or device which provides a liquid seal to prevent the emission of sewer gases without materially effecting the flow of sewage or waste water through it.

Trap Arm. A trap arm is that portion of a fixture drain or waste between a trap and its vent.

Trap Primer. A trap primer is a device or system of piping to maintain a water seal in a trap.

Trap Seal. The vertical distance between the crown weir and the top of the dip of the trap.

Troughs. An open conduit, drain, channel, trench or gutter.

2.03: continued

Vacuum. Any pressure less than that exerted by the atmosphere.

Vacuum Breaker, Non-Pressure Type (Atmospheric). See Anti-Siphon Vacuum Breaker -- Non-Pressure Type.

Vacuum Breaker, Pressure Type. See Anti-Siphon Vacuum Breaker -- Pressure Type

Vacuum Relief Valve. A device to prevent excessive vacuum in a water storage tank or heater.

Vent -- Automatic. A mechanical device that opens on negative pressure in the drainage system to prevent trap syphonage, and closes gas and water tight when the pressure in the drainage system is equal to or greater than ambient pressure to prevent the entry of sewer gas into the building.

Vent Pipe. Part of the Vent system.

Vent Stack. A vertical vent pipe installed to provide circulation of air to and from the drainage system.

Vent System. A pipe or pipes installed to provide a flow of air to or from the drainage system or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

Vertical Pipe. Any pipe or fitting which makes an angle of 45° or less with the vertical.

Wall Hung Water Closet. A wall mounted water closet installed in such a way that no part of the water closet touches the floor.

Waste. See Liquid Waste.

Waste Pipe. A pipe which conveys only waste.

Water Distributing Pipe. A pipe within the building or on the premises which conveys water from the water service pipe to the point of usage.

Water Main. A pipe used to convey public water supply.

Water Outlet. A water outlet, as used in connection with the water-distributing system, is the discharge opening for the water:
(1) to a fixture;
(2) to atmospheric pressure (except into an open tank which is part of the water supply system);
(3) to a boiler or heating system;
(4) to any water operated device or equipment requiring water to operate, but not a part of the plumbing system.

Water Service Pipe. The pipe from the water main or other source of water supply to the water distributing system of the building served.

Water Supply System. The water service pipe, the water distributing pipes, and the necessary connecting pipes, fittings, control valves, and all appurtenances in or adjacent to the building or premises.

Wet Vent. A wet vent is any waste pipe which also serves as a vent, on the same floor level.

Yoke Vent (Relief Vent-Foot). A pipe connecting upward from a soil or waste stack to a vent stack for the purpose of preventing pressure changes in the stack.

2.04: Scope and Application

(1) Scope

(a) The provisions of this Code shall govern the construction, removal, alteration, repair and inspection of Plumbing.

(b) All plumbing installed under authority of Section 21 of Chapter 142, General Laws shall conform to this Code and term "Administrative Authority" shall mean Investigator of Plumbers or Board of State Examiners of Plumbers and Gas Fitters.

(2) Licenses and Registration

(a) No person shall engage in the business of a master plumber or work as a journeyman or as an apprentice, nor solicit, by sign, listing or any other form of advertisement, work regulated or controlled by this chapter or by any ordinance, by-law, rule or regulation made hereunder, unless he is lawfully registered, or has been licensed by the examiners as provided in this chapter. Any person so licensed as a master plumber or a journeyman may carry on the work of a gas fitter throughout the commonwealth, notwithstanding any local ordinance, by-law, rule or regulation to the contrary, and may engage in the work of installing house drainage and connecting with common sewers without being required to have any local license therefor, but shall be subject to local regulations relative to permits and bonding requirements.

(b) The license or certificate of a journeyman or an apprentice shall be exhibited whenever required by an Inspector of Plumbing.

(c) The license or certificate of a master plumber shall at all times be displayed conspicuously within his place of business. Any sign, listing or advertisement of a master plumber or a journeyman shall contain his designation and license number.

(d) Each holder of a master or journeyman plumber's certificate or license shall register his name and business address with the Inspector of Plumbing if he has such control, otherwise with the Board of Health, in the city or town wherin he desires to engage in business as a plumber.

(e) A person, duly licensed in the Commonwealth as a master plumber and who wishes to conduct his plumbing business as a corporation, shall register with the Examiners and upon payment of the required fee, shall be issued a certificate authorizing him to conduct the plumbing business as a corporation.

(3) Permits.

(a) Plumbing shall not be installed, altered, removed, replaced, or

NON-TEXT PAGE

2.04: continued

repaired until a permit has been issued therefor by the Inspector of Plumbing. Any application for such permit shall be made to the Inspector of Plumbing and shall contain a statement of the work to be performed, the location of the building and the names of the persons for and by whom the work is to be done. Each permit which is issued by the Inspector of Plumbing shall be subject to the express conditions set forth therein as to compliance with all provisions of the statutes, rules and regulations which relate to plumbing. A separate permit shall be required for each building.

(b) The repair of leaks in a faucet, valve, or other working part of a plumbing fixture, and the clearance of a stoppage; but not including the alteration, replacement or relocation of any faucet, valve, or other working part of a plumbing fixture or device, water supply, sewer, drainage, leader soil, waste, vent or similar piping or work affecting public health shall be deemed a minor repair for which no permit shall be required.

(c) Permits to perform plumbing work shall be issued to licensed plumbers only.

Permits may be cancelled if in the opinion of the Inspector of Plumbing the code has been violated.

Permits shall be invalid if work is not started within 90 days of the date thereon, unless the holder of such permit or permits, can satisfactorily prove that failure to start within the 90 day period was beyond his control.

(4) Permit Applications and Fees. Applications for permits to perform plumbing in all cities and towns shall be made on a form prescribed by the Board of State Examiners of Plumbers and Gas Fitters, as authorized under the General Laws.

Fees to obtain permits to perform plumbing in a city or town, or in any building in such city or town, owned or operated by the Commonwealth, or any political sub-division of the Commonwealth, shall be determined by the city or town. Permits to perform plumbing shall be issued by the local Plumbing Inspector.

(5) Plans and Specifications. Whenever plans and specifications are necessary or requested by the Inspector of Plumbing for any plumbing work, prior to the issuance of a plumbing permit by the Inspector of Plumbing, such plans and specifications shall have thereon the name and address of the designer and a certification by the designer that said plans and specifications are in compliance with this Code. Plans and specifications shall not be required for minor repairs and alterations.

(6) Inspection. All new plumbing work and such portions of existing systems as may be affected by new work or any changes shall be inspected to insure compliance with all the requirements of this Code and to assure that the installation and construction of the plumbing system is in accordance with approved plans.

(7) Covering of Work.

(a) No drainage or plumbing system or part thereof shall be covered until it has been inspected, tested and accepted as prescribed in this Code.

(b) If any building drainage or plumbing system or part thereof which is installed, altered, or repaired, is covered before being inspected, tested, and approved, as prescribed in this Code, it shall be uncovered for inspection after notice to uncover the work

2.04: continued

has been issued to the responsible person by the Inspector of Plumbing.

(c) When new buildings or additions to existing buildings are to be constructed over existing sewers, these sewers shall be replaced with materials conforming to the requirements of this Code for inside the building application, unless otherwise approved by the Board of State Examiners of Plumbers.

(8) Notification. It shall be the duty of the holder of a permit to give notice to the Inspector when plumbing work is ready for test and/or inspection, and such holder of a permit shall make sure that the work will stand the test prescribed, and that the roughing-in has been completed as far as practicable before giving the notification. If the Inspector finds that the work will not pass the test and/or requirements of the Code, necessary corrections shall be made and the work shall be resubmitted for test and/or inspection.

(9) Material and Labor for Tests. The equipment, materials, power, and labor necessary for the inspection and test shall be furnished by the plumber.

(10) Tests of the Plumbing System. The piping of the plumbing, drainage, and venting systems shall be tested with water or air. After the plumbing fixtures have been set and their traps filled with water, the entire plumbing system shall be submitted to a final test and inspection. The Inspector of Plumbing may require the removal of any cleanouts, to ascertain if the pressure has reached all parts of the system.

(a) Test of the Rough Plumbing. Upon proper notice of a request for an inspection of the rough plumbing, the Inspector of Plumbing shall make the Inspection within 48 hours.

(b) The inspector shall, except in the case of emergencies, perform his duties and inspections during the normal working hours of the day.

(11) Methods of Testing.

(a) Water Test. The water test shall be applied to the drainage system either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water. In testing successive sections at least the upper 10 feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 feet of the system) shall have been submitted to a test of less than a 10 foot head of water. The water shall be kept in the system or in the portion under test, for at least 15 minutes before inspection starts: the system shall then be tight at all points.

(b) Air Test. The air test shall be made by attaching an air compressor testing apparatus to any suitable opening, and, after closing all other inlets and outlets to the system, forcing air into the system, until there is a uniform gauge pressure of 5 pounds per square inch or sufficient to balance a column of mercury 10 inches in height. This pressure shall be held without introduction of additional air for a period of at least 15 minutes.

(c) Final Test and Inspection. When the work in a building is sufficiently advanced that the water may be turned on to any or all of the fixtures, the plumber doing such work, shall, within five days, notify the Inspector of Plumbing. The Inspector of Plumbing shall, within two working days, after the receipt of such notice, proceed with the plumber or his workman and examine the work with the water turned on to the fixtures. If found satisfactory and fully completed, a certificate will be issued to this effect if desired. Should the examination disclose any defects, the plumber shall be required to remedy same, without delay, and again notify the

2.04: continued

Inspector of Plumbing, as before. Should a licensed plumber holding a permit card for work in a building, turn the water on to such and neglect to send the notification as required, or neglects to remedy any defects that may have been found and pointed out to him by the Inspector of Plumbing, for a period of over five days, he shall not be granted any further permits until he shall have complied with these rules, or until action is taken by the Inspector of Plumbing as provided for in Chapter 142 of the General Laws.

(12) Test of the Water Supply System. Upon completion of a section or of the entire water supply system when roughed, it shall be tested and proved tight under a pressure not less than 125 pounds per square inch. Water used for tests shall be obtained from a potable source of supply. Air or other inert gases may be used for testing.

(13) Defective Materials and Poor Workmanship. If, at the time of testing and inspection, any leaks, defective or patched materials, or evidence of unskilled or inferior workmanship be found, the same shall be condemned by the Inspector of Plumbing and ordered by him to be removed and corrected and no further progress shall be allowed on the work until the same is affected and the test renewed.

(14) Repairs and Alterations.

(a) In existing buildings or premises in which plumbing installations are to be altered, repaired, or renovated, deviations from the provisions of this Code are premitted, provided such deviations are found to be necessary, conform to the intent of this Code, and are approved by the Inspector of Plumbing.

(b) Whenever compliance with all of the provisions of this Code fails to eliminate or alleviate a nuisance which may involve health or safety hazards, the owner or his agent shall install such additional plumbing or drainage equipment as may be found necessary by the Inspector of Plumbing.

(15) Defective Plumbing.

(a) Whenever there is reason to believe that the plumbing system of any building has become defective, it shall be subjected to test and/or inspection, and any defects found shall be corrected as required in writing by the Inspector of Plumbing.

(b) Whenever additional plumbing, or alterations thereof, are being made, or installed, in the existing buildings or premises, and existing plumbing is found to be in violation of this Code to the point of being a health menace or nuisance, or a safety hazard, such existing plumbing shall be made to conform before any additional work may be completed.

(16) Maintenance. The plumbing and drainage system of any premises shall be caused to be maintained in a sanitary and safe operating condition by the owner or his agent.

(17) Demolition and Removal.

(a) When a fixture which is connected to the plumbing is permanently removed, a permit for the work shall be secured. All connections to such a fixture shall be made water and gas tight.

(b) Insofar as they are pertinent, the provisions of the above sub-paragraph shall also apply when a building or other structure is demolished.

(18) Violations. No person shall aid or abet any plumber to violate the provision of this Code; connive at its violation; or employ an unlicensed person or permit his employment in the performance of any work which is required by this Code to be done by a plumber.

(19) Approval of Plumbing Materials. All materials and plumbing

2.04: continued

fixtures used in any plumbing or drainage system or, part thereof shall meet with the approval of the Board of State Examiners of Plumbers and Gas Fitters.

(20) Appeal Procedure. Any person aggrieved by the decision of an Investigator or Inspector of Plumbing may appeal in writing to the Board of State Examiners of Plumbers and Gas Fitters for a hearing. The written appeal shall be accompanied with a check in the amount of twenty dollars, made payable to the Commonwealth of Massachusetts, shall be filed by the appellant with the Executive Secretary who shall schedule the hearing and notify all interested parties of same.

Should the Board of State Examiners of Plumbers and Gas Fitters find in favor of the appellant, the check deposited with the Board shall be returned to the appellant.

The decision of the Board of State Examiners of Plumbers and Gas Fitters shall be final.

(21) Right of Entry. The Administrative Authority shall, after proper identification, have the right to enter any premises for the purpose of inspecting any plumbing system and at such times as may be reasonably necessary to protect the public health.

2.05: General Regulations

(1) Conforming with this Code. All plumbing which is hereafter installed shall conform to the provisions of this Code.

(2) Pitch of Horizontal Drainage Piping.
(a) Horizontal drainage piping shall be run in practical alignment and at a uniform pitch.
(b) Horizontal drainage piping which is three inches or less in diameter shall be installed with a pitch of not less than one-quarter of an inch per foot.
(c) Horizontal drainage piping which is larger than three inches in diameter shall be installed with a pitch of not less than one-eighth of an inch per foot.
(d) Storm or sanitary sewers shall be installed at a slope which will produce a computed velocity of not less than two feet per second.

(3) Changes in Direction.
(a) Fittings to Be Used. Changes in direction of drainage piping shall be made by the use of wyes, long sweep quarter bends, fifth, sixth, eighth or sixteenth bends, or their equivalent. Quarter bends, or their equivalent, may be used in soil and waste lines where the change in the direction of flow is from the horizontal to the vertical. Tees and crosses may be used for changes in direction in vent piping. Short sweep fittings may be used in a branch waste line serving one outlet.
(b) Back to Back Fixtures. Shall be installed with fittings that will prevent the mixing of the discharge prior to a change in direction of flow of the discharge from each fixture or shall be installed with fittings especially designed to eliminate throw over from one discharge to the other.

(4) Fittings and Connections Prohibited.
(a) Fittings Prohibited. No fitting which has T branch shall be used as a drainage fitting. No fitting or connection which has an enlargement chamber or recess with a ledge or shoulder, or reduction in pipe area shall be used. No running threads, bands or saddles shall be used in the drainage system. No drainage or vent piping shall be drilled or tapped, burned or welded. A fitting

2.05: continued

commonly referred to as a Sisson Joint is prohibited.

(b) Obstruction to Flow. No fitting, connection, device, or method of installation which obstructs or retards the flow of water, wastes, sewage, or air in the drainage or venting systems in an amount greater than the normal frictional resistance to flow, shall be used unless it is indicated as acceptable to this Code as having a desirable and acceptable function and as of ultimate benefit to the proper and continuing functioning of the plumbing system. The enlargement of a 3-inch closet bend or stub to 4 inches shall not be considered an obstruction, provided the horizontal flow line or insert is continuous without forming a ledge.

(c) Dead Ends. In the installation or removal of any part of a drainage system, dead ends shall be avoided except where necessary to extend a cleanout so as to be accessible.

(d) Heel or Side-Inlet Bends. A heel or side-inlet quarter bend shall not be used as a dry vent when the inlet is placed in a horizontal position, or any similar arrangement of pipe and fittings producing a similar effect, unless the entire fitting is part of a dry vent arrangement.

(5) Trenching, Tunneling and Backfilling.

(a) Trenching and Bedding. Trenches shall be of sufficient width to permit proper installation of the pipe. Where shoring is required ample allowance shall be made in trench width for proper working conditions. Where trenches are excavated to grade such that the bottom of the trench forms the bed for the pipe, care must be exercised to provide solid bearing between joints and Bell holes shall be provided at points where the pipe is joined. Where trenches are excavated below grade such that the bottom of the trench does not form the bed for the pipe, the trench shall be back-filled to grade with sand tamped in place so as to provide a uniform bearing for the pipe between joints. Where rock is encountered in trenching, it shall be removed to a point at least three inches below the grade line of the trench and the trench shall be backfilled to grade with sand tamped in place so as to provide a uniform bearing for the pipe between joints. Care shall be exercised to see that the pipe does not rest on rock at any point including the joints. If soft materials of poor bearing qualities are found at the bottom of the trench, a concrete foundation shall be provided to insure a firm foundation for the pipe. Such concrete foundation shall be bedded with sand tamped in place so as to provide a uniform bearing for the pipe between joints.

(b) Tunneling. Where necessary, pipe may be installed by tunneling or jacking, or a combination of both. In such cases, special care shall be exercised to protect the pipe from damage either during installation or from subsequent uneven loading. Where earth tunnels are used, adequate supporting structures shall be provided to prevent future settling or caving. Pipe may be installed in larger conduit which has been jacked through unexcavated portions of the trench.

(c) Backfilling. Until the crown of the pipe is covered by at least 2 feet of tamped earth considerable care shall be exercised in backfilling trenches. Loose earth, free of rocks, broken concrete, frozen chunks and other rubble, shall be carefully placed in the trench in 6-inch layers and tamped in place. Care shall be taken to thoroughly compact the backfill under and beside the pipe to be sure that the pipe is properly supported. Backfill shall be brought up evenly on both sides of the pipe so that it retains proper alignment.

(d) Safety Precautions. All laws, rules and regulations pertaining to safety and protection of workmen, other persons in the vicinity, and neighboring property shall be observed where excavating, trenching, blasting, or other hazardous operations are being conducted.

2.05: continued

(6) Structural Safety. In the process of installing or repairing any plumbing installation, the finished floors, walls, ceilings, tile work or any other part of the building or premises which must be changed or replaced shall be left in a safe structural condition.

(7) Workmanship. Workmanship shall conform to generally accepted good practice.

(8) Protection of Piping.

(a) Corrosion. A pipe that passes through, under, or in contact with cinders, concrete or other corrosive material shall be protected against external corrosion by a protective coating, wrappings, or other means which will prevent such corrosion.

(b) Cutting or Notching. A structural member shall not be weakened or impaired by cutting, notching, etc., except to the extent permitted by the Inspector of Buildings.

(c) Freezing. No water supply and/or drainage piping shall be installed outside of, or under, a building in an exposed, open and/or unheated area, or in an exterior wall unless adequate provision is made to protect such pipes from freezing.

The protection and covering of such pipes shall be the responsibility of the installing plumber.

(d) Rat Proofing. All strainer plates on drain inlets shall be designed and installed so that no opening is greater than 1/2" in least dimension.

Meter boxes shall be constructed in such a manner that rats cannot enter a building by following the service pipes from the box into the building.

(9) Damage to Drainage System or Sewer. No person shall deposit by any means into a building drain or sewer any ashes, cinders, rags, inflammable, corrosive or explosive liquid, gas, oil, grease, or any other material which would or could obstruct, damage, or overload such a drain or sewer.

(10) Detrimental Wastes. A waste which is detrimental to the public sewer system or to the functioning of the sewage treatment plant shall be treated and disposed of according to the requirements of the State or Federal authorities having jurisdiction.

(11) Sleeves. The annular space between the sleeve and a pipe which passes through an exterior wall shall be made water tight or weather tight.

(12) Second Hand Plumbing Material. No person shall install second hand plumbing material or a plumbing fixture unless it complies with the minimum standard set forth in this Code, but, before it is installed, a second hand plumbing fixture shall be thoroughly cleansed and disinfected.

(13) Piping in Relation to Footings.

(a) Outside of Footings. Piping which is installed outside of and below a footing shall not destroy the bearing value of the soil.

(b) Through or Under Footings, Foundations or Walls. No pipe shall be installed through or under a footing foundation or wall, unless provision is made in the footing to carry the building or structural loads without transmitting such loads to the pipe.

(14) Drainage Below Sewer Level. Drainage piping which is located below the sewer shall be installed as provided in 248 CMR 2.15.

(15) Connections to Plumbing System Required. All plumbing fixtures, drains and appurtenances which are used to receive or discharge liquid waste or sewage shall be properly connected to the

2.05: continued

drainage system of the building or premises in accordance with the requirements of this code.

(16) Sewage Disposal Connections (Buildings). The plumbing of each building shall have an independent connection to a public sanitary sewer outside of building, unless, in the opinion of the Inspector of Plumbing, a separate connection is not feasible. If a public sanitary sewer is not available, the sewage shall be discharged into a septic tank with an overflow into a leeching pit or into a subsurface distribution system, in compliance with Article XI* of the State Sanitary Code of the Massachusetts Department of Environmental Quality Engineering.

(17) Location of Fixtures

(a) Light and Ventilation. Plumbing fixtures shall be located in compartments, rooms, or areas which are provided with ventilation and illumination that conform to Article II of the State Sanitary Code.

(b) Improper Location. Piping, fixtures, or equipment shall not be installed in such a manner as to interfere with the normal operation of windows, doors, or other openings.

(c) Piping Measurement. Except where otherwise specified in this Code, all measurements between pipes or between pipes and walls, etc., shall be made to the center lines of the pipes.

2.06: Materials

(1) Materials.

(a) Minimum Standards. All materials, systems, and equipment used in the construction, installation, alteration, repair, replacement, or removal or any plumbing or drainage system or part thereof, shall conform at least to the standards listed in this Section and be approved by the Board, except that:

1. The Inspector may allow the extension, addition to or relocation of existing water, soil, waste and/or vent pipes with materials of like grade or quality as permitted under 248 CMR 2.04(14)(a); or

2. Materials not covered by the standards listed in this Section may be used with the approval of the Board as permitted under 248 CMR 2.06(2)(t).

(b) Installation. All materials installed in plumbing systems shall be so handled and installed as to avoid damage so that the quality of the material will not be impaired.

No defective or damaged materials, equipment or apparatus shall be installed or maintained.

All materials used shall be installed in strict accordance with the standards under which the materials are accepeted and approved, including the appendices of the standards, and in strict accordance with the manufacturer's instructions.

(c) Standards and Approval. A material shall be considered approved if it meets one or more of the standards listed in Table 1 in 248 CMR 2.06, Standards for Plumbing Materials and has been designated by the Board for specific use, or uses, in this Section or other sections of this Code. Plastic pipe and fittings shall also meet the listed standard of the N.S.F. Materials not listed in Table 1 in 248 CMR 2.06 shall be used only as provided for in 248 CMR 2.06(2)(a) or as permitted elsewhere in this Code.

NOTE 1. Abbreviations in Table 1 in 248 CMR 2.06 refer to the following organizations:

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* Article of the State Sanitary Code was superseded by Title V of the Environmental Code, 310 CMR 15.00.

2.06: continued

ANSI -- American National Standards Institute, 1430 Broadway, New York, New York 10018,
ASSE -- American Society of Sanitary Engineering, 228 Standard Building, Cleveland, Ohio 44113.
ASTM -- American Society for Testing & Materials, 1916 Race Street, Philadelphia, Pennsylvania, 19103,
AWWA -- American Water Works Association, 521 Fifth Avenue, New York, New York 10017,
CDA -- Copper Development Association, 405 Lexington Avenue, New York, New York 10017,
CISPI -- Cast Iron Soil Pipe Institute, 2029 K Street, N.W., Washington, D.C. 20006,
CS -- Commmercial Standards, Commodity Standards Division, Office of Industry and Commerce, U.S. Department of Commerce, Washington, D.C. 20230,
FS -- Federal Supply Service, Standards Division, General Services Administration, Washington, D.C. 20405,
MSS -- Manufacturers Standardization Society, of the Valve and Fittings Industry, 1815 North Fort Myer Drive, Arlington, Virginia 22209,
NBS -- National Bureau of Standards, U.S. Department of Commerce, Washington, D.C. 20234,
NFS -- National Sanitation Foundation, PO Box 1468 NSF Building, Ann Arbor, Michigan 48106,
PDI -- Plumbing and Drainage Institute, 1018 N. Austin Boulevard, Oak Park, Illinois 60302,
PPI -- Plastic Pipe Institute, 250 Park Avenue, New York, New York 10017,
PS -- Product Standards published by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402,

NOTE 2. Since material standards and specifications are subject to change, the designations carrying indication of the year of issue may thus become obsolete. Table 1 in 248 CMR 2.06 gives the full designations of standards current when this Code was printed. This table will be reviewed and updated by the Board at regular intervals.

(d) Identification. Materials shall be identified as provided in the standard to which they conform.

(2) Allowable Materials.

(a) Lead. Sheet lead shall be not less than the following:
For a safe pan -- not less than four (4) pounds per square foot.
For vent terminal flashing -- not less than three (3) pounds per square foot.
For bends or traps -- not less than 1/8" wall thickness.

2.06: continued

TABLE 1.

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Ferrous Pipe, Fittings and Valves				
Cast Iron Drainage Fittings, Threaded	B16.12-1972	None	WW-P-491b-1967	None
Cast Iron Screwed Fittings (Threaded)	B16.4-1971	None	WW-P-501d-1967	None
Cast Iron Pipe (Threaded) D.W.V.	A40.5-1943	None	WW-P-356a-1967	None
Cast Iron Pipe, Thickness Design of	A21.1-1967	None	WW-P-421c-1967	AWWA H1-67
Cast Iron Soil Pipe and Fittings Extra Heavy and Service Weights	A112.5.1-1971	A74-72	WW-P-401d-1969	CS 188-66
Cast Iron Water Pipe (2")	A21.12-1971	A377-66	WW-P-360b-1968	AWWA C112-71
Cast Iron Water Pipe (Cast in metal molds)	A21.6-1970	A37-66	WW-P-421c-1967	AWWA C106-70
Cast Iron Water Pipe (Cast in sand lined molds)	A21.8-1970	A377-66	WW-P-421c-1967	AWWA C108-70
Cast Iron Water Pipe Fittings	A21.10-1971	A377-66	None	AWWA C110-71
Ductile - Iron Pipe	A21.51-1971	A377-66	WW-P-421c-1967	AWWA C151-71
Hubless Cast Iron Sanitary System with No-Hub System Fittings	None	None	None	CISPI 301-71
Malleable Iron Screwed Fittings, 150 lbs.	B16.3-1971	None	WW-P-521f-1968	None
Nipples, Pipe, Threaded	None	None	WW-N-351b(1)-1970	CS-5-65
Pipe Fittings, Ferrous (Bushings, plugs, and locknuts) Threaded, 125 and 150 lbs.	B16.14-1971	None	WW-P-471b-1970	None
Pipe Threads (except Dry seal)	B2.1-1968	None	None	NBS Handbook H28-Part II-1966
Steel Pipe, Stainless	B125.16-1970	A312-72a	None	None
Steel, Stainless, Water-DWV Tubes, Copper Coated	None	A268-71	None	None

NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various sections of this Code.

2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Ferrous Pipe, Fittings and Valves				
Steel Pipe, Welded or Seamless (for coiling) Black or Galvanized	B125.1-1970	A53-71a	WW-P-471b-1970 Int Amend 3-1971	None
Steel Pipe, Welded or Seamless Black or Galvanized	B125.2-1970	A120-71a	WW-P-404c(1)-1962	None
Steel Pipe (Cement-mortar lining and Reinforced Cement-mortar coating)	A21.4-1971	None	SS-P-385a(1)-1968	AWWA C205-62T AWWA C104-70
Steel Pipe (Coal tar enamel or cement mortar lining and coal tar enamel coated and wrapped)	None	None	WW-P-1432-1970	AWWA C203-66
Unions, Pipe, Steel or Malleable Iron	None	None	WW-U-531c-1965	None
Valves, Ball	None	None	WW-V-35a-1965 Int Amend 2-1970	None
Valves, Cast Iron, Gate 125 and 250 lb.	None	None	WW-V-58b-1971	MSS-SP-70-1970
Valves, Cast Iron, Swing check	None	None	None	MSS-SP-71-1970
Wrought Iron Pipe, Welded, Black or Galvanized	B36.2-1969	A 72-68	None	None
Non-Ferrous Metallic Pipe, Fittings and Valves				
Brass Tube, Seamless	H36.1-1969	B135-72a	WW-T-791a-1971	None
Brass, Red, Seamless, Pipe, Standard Sizes	H27.1-1967	B 43-72	WW-P-351a-1963	None
Bronze Flanges and Flanged Fittings	B16.24-1971	None	None	None
Cast Bronze Fittings for Flared Copper Tubes	B16.26-1967	None	None	None
Cast Bronze Solder-joint Pressure Fittings	B16.18a-1967	None	WW-T-00725-1967	None

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Non-Ferrous Metallic Pipe, Fittings and Valves				
Cast Bronze Solder-joint Drainage Fittings	B16.23-1969	None	None	None
Copper Pipe, Seamless, Standard Sizes	H26.1-1967	B42-72	WW-P-377d-1962	None
Copper Pipe, Threadless	H26.2-1967	B302-70	WW-P-377d-1962	None
Copper Tube, Drainage DWV	H23.6-1970	B306-72	None	None
Copper Tube, Seamless	H23.3-1970	B 75-72	WW-T-797c-1963	None
Copper Tube, Water, Seamless, Types K, L, and M	H23.1-1970	B 88-72	WW-T-799d-1971	None
Copper and Copper Alloy Pipe and Tube, General Requirements	H23.4-1970	B251-71	None	None
Copper and Copper Alloy Tube (Welded)	None	B543-72	None	PS29-69
Lead Pipe, Bends and Traps	None	None	WW-P-325a-1967	None
Pipe Fittings, Brass or Bronze, 125 and 250 lbs., Cast or Wrought	B16.15-1971	None	WW-P-460b-1967	None
Pipe Nipples: Brass, Copper, Steel and Wrought Iron	None	None	None	CS-5-65
Solder-joint Fittings, Pressure, Copper Alloy	B16.22-1963	None	WW-T-00725-1967	None
Solder-joint Fittings, Drainage, Copper Alloy	B16.29-1966	None	None	None
Unions, Brass or Bronze, 250 lbs.	None	None	WW-U-516a-1967	None
Valve, Ball, Copper Alloy, Iron or Steel	None	None	WW-V-35a-1965 Int Amend 2-1970	MSS-SP-72-1970
Valves, Gate, Bronze, Threaded and Flanges	None	None	WW-V-54c-1966 Int Amend 1-1970	None

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Non-Ferrous Metallic Pipe, Fittings and Valves				
Valves, Angle, Check and Globe, Bronze, 125 lb. Screwed, Flanged or Solder	None	None	WW-V-51d-1967	None
Non-Metallic Pipe and Fittings				
Asbestos Cement Non-pressure Sewer Pipe	A165.3-1971	C428-72	SS-P-331c-1967	None
Asbestos Cement Non-pressure Small Diameter Sewer Pipe (4", 5", 6")	A165.4-1971	C644-71	None	None
Asbestos Cement Perforated Underdrain Pipe	A165.2-1971	C508-70	SS-P-340b-1969	None
Asbestos Cement Pressure Pipe	None	C296-72	SS-P-351c-1968	AWWA C400-65
Asbestos Cement Storm Drain Pipe	None	C663-71	None	None
Asbestos Cement Transmission Pipe	None	C668-70	None	None
Bituminized Fiber Drain and Sewer Pipe, Homogeneous Wall	A176.1-1971	D1861-69	SS-P-1540a-1969 Int Amend 1-1970	CS116-54
Bituminized Fiber Drain and Sewer Pipe, Laminated Wall	A176.2-1971	D18G2-74 (1971)	SS-P-1540a-1969 Int Amend 1-1970	CS226-59
Bituminized Fiber Pipe, Perforated, for Septic Tank Disposal Fields, Homogeneous Wall	A176.4-1971	D2312-69	SS-P-1540a-1969 Int Amend 1-1970	None
Bituminized Fiber Pipe, Perforated, for Septic Tank Disposal Fields, Laminated Wall	A176.5-1971	D2313-65 (1970)	SS-P-1540a-1969 Int Amend 1-1970	None

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Non-Metallic Pipe and Fittings				
Clay Drain	A6.1-1963	C4-62 (1970)	SS-P-1299a-1968	None
Clay Drain Tile, Perforated	None	C498-65 (1972)	SS-P-359b-1960	None
Clay Pipe, Extra Strength	None	C700-71T	None	CS224-60
Clay Pipe, Perforated, Standard and Extra Strength	A106.1-1969	C700-71T	SS-P-359b-1960	CS143-60
Clay Sewer Pipe, Standard Strength	A106.3-1967 (1969)	C700-71T	SS-P-361d-1968	CS224-60
Concrete Drain Tile	None	C412-72	None	None
Concrete Low Head Pressure Pipe, Reinforced	None	C361-72	None	None
Concrete Pipe, Perforated	None	C444-68	None	None
Concrete Pipe, (Sewer, Storm Drain and Culvert) Non-reinforced	None	C14-71	SS-P-371e-1968	None
Concrete Pipe, Pressure, Reinforced Concrete, pretensioned reinforcement (Steel Cylinder Type)	None	None	SS-P-381a(1)-1969	None
Concrete Pipe (Culvert, Storm Drain, and Sewer) Reinforced	None	C76-72	SS-P-375d-1970	None
Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80	B72.5-1971	D1527-71	None	PS-18-69
Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, (SDR-PR and Class T)	B72.3-67	D2282-71	None	PS-19-69 NSF 14
Socket-Type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40	K65.164-1971	D2468-69	None	NSF 14

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Non-Metallic Pipe and Fittings				
Socket-Type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 80	K65.163-1971	D2469-69	None	NSF 14
Threaded Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 80	K65.165-1971	D2465-69	None	NSF 14
Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste, and Vent Pipe and Fittings	B72.18-1971	D2661-68	L-P-322a-1966	CS270-65 NSF 14
Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings	B72.23-1971	D2235-67 (1972)	None	None
Polyethylene (PE) plastic pipe, Schedule 40	B72.8-1971	D2104-71	None	NSF 14 PS10-69
Polyethylene (PE) Plastic Pipe, Schedules 40 and 80 Based on Outside Diameter	B72.13-1971	D2447-71	None	NSF 14 PS12-69
Polyethylene (PE) Plastic Pipe, (SDR-PR)	B72.1-1970	D2239-71a	L-P-315a-1966 L-P-C0315b-1937	PS11-69 NSF 14
Butt Fusion Polyethylene (PE) Plastic Pipe Fittings, Schedule 40	K65.160-1971	D2610-68	None	None
Butt Fusion Polyethylene (PE) Plastic Pipe Fittings, Schedule 80	K65.159-1971	D2611-68	None	None
Plastic Insert Fittings for Polyethylene Plastic Pipe	B16.27-62	D2609-70	L-F-001546-1968	NSF 14
Polyethylene (PE) Plastic Tubing	None	D2737-71	None	None
Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot-Water Distribution Systems	None	D2846-70	None	None PS21-70

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Non-Metallic Pipe and Fittings				
Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120	B72.7-1971	D1785-68	None	NSF 14
Socket-Type Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40	None	D2466-69	None	NSF 14
Socket-Type Polyvinyl Chloride (PVC) Plastic-Pipe Fittings, Schedule 80	None	D2467-69	None	NSF 14
Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings	B72.16-1972	D2564-67 (1972)	None	None
Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80	K65.166-1971	D2464-69	None	NSF 14
Bell-End Polyvinyl Chloride (PVC) Pipe	B72.20-1971	D2672-68a	None	None CS272-65
Polyvinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings	K65.56-1971	D2665-68	L-P-320a-1966	NSF 14
Solvent Cement for Styrene Rubber Plastic Pipe, and Fittings	None	D3122-72	None	None
Pipe Joining Materials and Gaskets, and Supports				
Calking, Lead Wool and Lead Pig.	None	None	QQ-C-40(2) 1970	None
Compression Couplings for Vitrified Clay Bell and Spigot Pipe	None	C425-72	None	None
Compression Couplings for Vitrified Clay Plain End Pipe	None	C594-72	None	None

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Pipe Joining Materials and Gaskets, and Supports				
Fixture Setting Compound	None	None	TF-P-001536(1968) Revision of HHC 536a-1954	None
Non-Metallic Gaskets for Pipe Flanges	B16.21-1962	None	None	None
Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil-Pipe and Fittings	None	None	None	CISPI HSN 68T
Rubber Gaskets for Cast Iron Soil-Pipe and Fittings	None	C564-70	None	None
Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings	A21.11-1964	None	None	AWWA C111-64
Rubber Gaskets, Molded or Extruded, for Concrete Non Pressure Sewer Pipe	None	C443-72	HH-G-160b-1968	None
Rubber Rings for Asbestos Cement Pipe	J8.7-1971	D-1869-66 (1972)	None	None
Rubber Gaskets, Sheet	J7.2-1971	D-1330-66 (1972)	None	None
Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints	None	None	SS-S-00210 (1965)	None
Sealing Compound, Sewer, Bituminous, Two-Component, Mineral-Filled, Cold Applied	None	None	SS-S-168(2)1962	None
Pipe Hangers and Supports	None	None	WW-H-171d-1970	MSS-SP-58
Plumbing Appliances and Appurtenances				
Dishwashing Machines, Commercial	None	None	OO-D-431c(2)1970	ASSE 1004
Dishwashing Machines, Household	C33.69-1971	None	None	ASSE 1006

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Plumbing Appliances and Appurtenances				
Drinking Water Coolers, Self Contained Mechanically Refrigerated	A112.11.1-1968	None	None	None
Food Waste Disposer Units, Commercial	None	None	None	ASSE 1009
Food Waste Disposer Units, Household	C33.59-1970	None	QQ-G-001513-1968	ASSE 1008
Home Laundry Equipment	C33.13-1968	None	None	ASSE 1007
Tanks for Domestic Use, Porcelain Enameled	None	None	None	CS 115-60
Water Heaters, Automatic Storage Type	Z21.10.1-1971	None	None	None
Water Heaters, Circulating Tank	Z21.10.3-1971	None	None	None
Water Heater, Electric Storage Tank	None	None	W-H-196h-1971	None
Water Heater, Instantaneous	None	None	WW-H-191b-1970	None
Water Heater, Side Arm Type	Z21.10.1-1962 Z21.10.2a-1963	None	None	None
Accessories for Plumbing Fixtures	None	None	WW-P-00541/8-1969	None
Bathtubs	None	None	WW-P-00541/3-1969	None
Bathtub Units, Gel-coated, Glass-Fiber Reinforced Polyester Resin	Z124.2-1967	None	None	None
Drinking Fountains	None	None	WW-P-00541/16-1969	None
Fittings, Plumbing Fixtures, Finished and Rough Brass	A112.18.1-1971	None	None	None
Floor Drains	A112.21.1-1968	None	None	None
Lavatories	None	None	WW-P-00541/4-1970	None
Lavatory, Cultured Marble	None	None	None	None
Plumbing Fixture, General Specification	None	None	WW-P-00541gC/Gen	None
Plumbing Fixtures, for Land Use	None	None	WW-P-541b(4)-1963 Int Amend 6	None
Plumbing Fixtures, Earthenware, Vitreous Glazed	None	None	None	CS 111-43
Plumbing Fixtures, Enameled Cast Iron	None	None	None	CS 77-63

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Plumbing Appliances and Appurtenances				
Plumbing Fixtures, Stainless Steel	None	None	None	CS 243-62
Plumbing Fixtures, Staple Vitreous China	None	None	None	CS 20-63
Shower Baths and Heads and Water Control Valves	None	None	WW-P-00541/7-1969	None
Shower Receptors, Shower Enclosure and Metallic Bathtubs, Prefabricated	None	None	None	None
Shower Receptor and Shower Stall Units, Gel-coated, Glass Fiber Reinforced Polyester Resin	Z124.2-1967	None	None	None
Sinks, Kitchen and Service, and Laundry Tub	None	None	WW-P-00541/5-1969	None
Supports for Off-the-Floor Plumbing Fixtures for Public Use	A112.6.1-1970	None	None	None
Urinals	None	None	WW-P-00541/1-1970	None
Water Closets	None	None	WW-P-00541/1-1969	None
Water Closet Flush Tank Ball Cocks, Antisyphon	None	None	None	ASSE 1002
Miscellaneous				
Adapters, Tubing Trap Wall	None	None	None	None
Air Gap Standards	A40.4-1942	None	None	None
Arrestors, Water Hammer	A112.26.1-1969	None	None	ASSE 1010 PDI WH-201
Backflow Preventers-Back Pressure (Reduced Pressure Principal)	None	None	None	ASSE 1013
Enamel, Coal-Tar, (Protective Coating)	None	None	None	AWWA C203-66

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2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Miscellaneous				
Clamps, Hose	None	None	WW-C-440b(a)-1969	None
Coating, Pipe, Thermoplastic Resin or Thermosetting, Epoxy	None	None	L-C 530B-1970	None
Connector, Water, Flexible Copper	None	None	None	None
Copper, Sheet and Strip for Building Construction	None	B270-66	None	None
Devices, Backflow Prevention (Reduced Pressure and Double Check)	None	None	None	ASSE 1015 AWWA C506-69
Drain for Prefabricated and Precast Showers	None	None	None	None
Drain, roof	A112.21.2-1971	None	None	None
Interceptors, Grease	None	None	None	PDI G 101
Drain, Floor	A112.21.1-1968	None	None	None
Lead, Sheet, Grade A	None	None	QQ-L-201f(2)1970	None
Plugs, Brass Cleanout	None	None	None	CS 188-66
Preventers, Backflow with Intermediate Atmospheric Vent	None	None	None	ASSE 1012
Relief Valves, Automatic	Z21.22-1971	None	None	None
Reducing Valves, Water Pressure for Domestic Water Supply System	None	None	None	ASSE 1003 & 1003-1
Solder, Soft	None	None	QQ-S-571d-1963	None
Septic Tank, metal, bituminous-coated	A612.1-1970	None	None	None
Septic Tank, Steel	None	None	None	CS177-62
Tape, Pipe Coating, Pressure Sensitive Polyethylene	None	None	L-T-0075(1)-1966	None
Tee, Diversion and Twin Waste Elbow	None	None	None	None

NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various sections of this Code.

2.06: continued

TABLE 1. (continued)

STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

Description	ANSI	ASTM	FS	Other
Miscellaneous				
Vacuum Breakers, Hose Connection	None	None	None	ASSE 1011
Vacuum Breaker, Pipe Applied Atmospheric Type	A112.1.1-1971	None	None	ASSE 1001
Valve, Backwater	None	None	None	IAPMO PS8-66
Valve, Drain, Water Heater	None	None	None	ASSE 1005

NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various sections of this Code.

2.06: continued

(b) Copper. Sheet Copper shall be not less than the following:

For safe pan or shower pan, flush tank linings, vent terminal flashing and general use -- not less than twelve (12) ounces per square foot.

(c) Floor Flanges. Floor flanges for water closets or similar fixtures shall be not less than 1/8 inch thick for brass, 1/4 inch and not less than 2 inches caulking depth for cast iron. If of hard lead, they shall weigh not less than 1 lb. 9 oz. and be composed of lead alloy with not less than 7.75% antimony by weight. Approved copper and plastic flanges may be used. Plastic flanges must meet current NSF Standards and shall be of the same material to which it connects.

Flanges shall be secured to the floor on which it sets by screwing or bolting, and shall be connected to the piping by soldering, caulking or solvent welding in an approved manner.

(d) Cleanouts. Cleanout plugs shall be of brass or plastic, meet the latest Standards, and shall have raised or countersunk square heads. Where a tripping hazard may exist, only countersunk heads shall be used.

Plastic cleanout plugs shall be of the same material to which they connect.

(e) Building Drains (Inside Building). If the Sanitary Drain and/or Storm Drains are installed in the same trench with the water service pipe, the drain shall be cast iron soil pipe tarred with lead and oakum joints.

(f) Storm and Sanitary Below Ground.

1. Extra heavy cast iron soil pipe and fittings, coated tar or asphaltum. Joints to be made with packed oakum and molten lead or resilient gaskets.

2. Iron size brass or copper pipe with cast brass drainage fittings.

3. Hard drawn type K or L copper tubing, with cast brass drainage pattern fittings.

4. Copper alloy tubing "Heavy" weight conforming to ASTM Standard, color coded aqua and incised marked as "Heavy", with cast brass drainage pattern fittings.

5. Grade H or SL copper coated stainless steel tubing conforming to ASTM Standard, made of Type 430 or Type 439 stainless steel, marked in conformance with 248 CMR 2.06(2)(p). Fittings to be cast brass drainage pattern.

6. ABS (Acrylonitrile-Butadiene-Styrene) Schedule 40 pipe and fittings as specified under 248 CMR 2.06(2)(o).

7. PVC (Polyvinyl-Chloride) Schedule 40 pipe and fittings as specified under 248 CMR 2.06(2)(n).

8. See 248 CMR 2.13 for materials to be used underground for Special Wastes.

9. For Storm Water Drainage only. Approved epoxy re-enforced fiberglass piping system.

10. Service weight cast iron soil pipe and fittings. Tarred or plain joints to be made with packed oakum and molten lead or resilient gaskets.

11. Hubless cast iron soil pipe and fittings, manufactured in accordance with CISPI Standard 301-75, joined with a clamp from a list of approved clamps from the Board of State Examiners of Plumbers and Gas Fitters and installed in strict accordance with the standards under which the materials are accepted and approved.

a. All couplings, regardless of material and type, shall be required to use the complete and full depth of purchase that is available as per the dimensions of the fittings manufactured in accordance with CISPI Standard 301-75 (no later issue).

b. Test Requirements.

[1] Every manufacture shall perform the pressure and leak test as required under 245 CMR 2.06(2)(u).

2.06: continued

[2] Deflection Test. A test deflecting the free end of a 10 foot length of hubless cast iron soil pipe joined together with a coupling to a secured length of pipe. The test assembly shall be subjected to an internal hydrostatic pressure of 10 PSI and a minimum deflection of one inch per lineal foot and shall show no visible signs of leakage.

[3] Shear Test. The shear test requires the application of a uniformly distributed force or weight of 50 pounds per inch of nominal diameter of the pipe over an arc of 120 degrees and along a longitudinal distance of 12 inches of the unsupported end of the two coupled lengths of pipe immediately adjacent to the assembled joint. The other end of the test assembly shall be rigidly secured and the entire unit shall be under an internal hydrostatic pressure of 10 PSI and shall show no visible signs of leakage.

[4] All tests shall be performed in the Commonwealth of Massachusetts and certified as per 248 CMR 2.06(2)(u)5.

c. Installations. Installations of hubless systems underground shall conform to 248 CMR 2.05(1), (2)(a) through (d) and 2.06(1)(b).

d. Trenching, Tunneling and Backfilling. Trenching, tunneling and backfilling procedures shall conform to 248 CMR 2.05(5)(a) through (d) and 2.06(2)(f)11.e.

e. Hangers and Supports.

[1] General piping shall be installed with provisions for expansion, contraction or structural settlement.

[2] Material. Hangers, anchors and supports shall be of metal with sufficient strength to support the piping and its contents except that piers may be of concrete or brick.

[3] Attachments to Buildings or Structures. Hangers and anchors shall be securely attached to the building or structure and shall be installed with (12") on each side of each clamp.

[4] Base of Stacks. Bases of stacks shall be supported on concrete, brick laid in cement mortar or metal brackets attached to the building or structure.

[5] Hubless Fittings.

[a] There shall be a hanger installed at each change of direction.

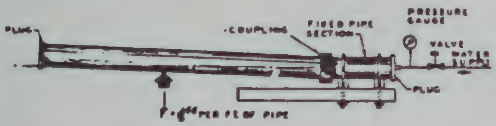
[b] When joining (3) three or more fittings, there shall be a minimum of (1) one hanger for every (3) feet or part thereof.

[6] Backfilling. The plumber holding the permit for the underground installation shall notify the plumbing inspector when the installation is to be backfilled and, further, he or a licensed plumber shall be present during the backfilling procedure and when all slabs are being poured. This notification provision shall not be subject to the forty-eight (48) hour notice requirement of 248 CMR 2.04.

2.06: continued

TEST FOR HUBLESS SOIL PIPE UNDERGROUND COUPLINGS

DEFLECTION TEST

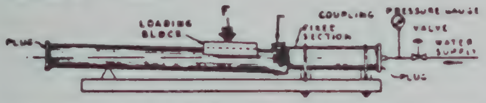


PROCEDURE: the free end of the 10ft. length of pipe was deflected 1" per foot of pipe length, while the length of pipe, on the other side of the coupling, was secured. The test assembly was subjected to an internal hydrostatic pressure of 10PSI during the test.

RESULTS:

1½" coupling	no leakage was noted
2" coupling	no leakage was noted
3" coupling	no leakage was noted
4" coupling	no leakage was noted
5" coupling	no leakage was noted
6" coupling	no leakage was noted
8" coupling	no leakage was noted
10" coupling	no leakage was noted

SHEAR TEST



PROCEDURE: A force of 50 pounds per inch of nominal diameter of pipe per 12 inch longitudinal distance was applied over an arc of 120° and along the longitudinal dimension of the unsupported end of the two coupled lengths of pipe. The other end of the test assembly was rigidly secured. A Unite-O-Matic Universal Tester, with a load cell and a recorder, was used to apply the load. The load was held for one hour. the test assembly was subjected to an internal hydrostatic pressure of 10 PSI during the test. The maximum deflection of the coupling joining the two pieces of pipe was also noted.

RESULTS:		Maximum Coupling Deflection
1½" coupling	no leakage	
2" coupling	no leakage	
3" coupling	no leakage	
4" coupling	no leakage	
5" coupling	no leakage	
6" coupling	no leakage	
8" coupling	no leakage	
10" coupling	no leakage	

2.06: continued

(g) Storm and Sanitary Above Ground.

1. Extra heavy cast iron soil pipe and fittings, tarred or plain. Joints to be made with packed oakum and molten lead or resilient gaskets.

2. Service weight cast iron soil pipe and fittings. Tarred or plain joints to be made with packed oakum and molten lead or resilient gaskets.

3. Hubless cast iron soil pipe and fittings, manufactured in accordance with CISPI Standard 301-75, and joined with a clamp approved by the Board of State Examiners of Plumbers and Gas Fitters.

4. Iron size brass or copper pipe with cast brass drainage fittings.

5. Hard drawn Type K, L, M or DWV copper tubing, with cast brass or wrought copper drainage pattern fittings.

6. Copper alloy tubing "Heavy" and "Standard" weights conforming to ASTM Standard, color coded aqua and incised marked as either "Heavy" or "Standard", with cast brass or wrought copper drainage pattern fitting.

2.06: continued

7. Grades, H, G, SL or SM copper coated stainless steel tubing conforming to ASTM Standard, manufactured of Type 430 or Type 439 stainless steel, plainly marked in conformance with 248 CMR 2.06(2)(p). Fittings to be cast brass or wrought copper drainage pattern.
8. Schedule 40 galvanized wrought iron or galvanized steel pipe with plain or galvanized drainage pattern fittings on sizes above two (2) inches. This material may also be used when pipe and fittings are end grooved to be joined with an approved split and bolted galvanized steel coupling with gasket.
9. Approved groove type couplings and fittings may be used for joining storm water piping.
10. ABS (Acrylonitrile-Butadiene-Styrene) Schedule 40 pipe and fittings as specified under 248 CMR 2.06(2)(o).
11. PVC (Polyvinyl-Chloride) Schedule 40 pipe and fittings as specified under 248 CMR 2.06(2)(n).
12. See 248 CMR 2.13 for materials to be used above ground for Special Wastes.
13. For Storm Water Drainage only. Approved epoxy re-enforced fiberglass piping system.

(h) Vent Pipe and Fittings Below Ground.
1. All materials listed under 284 CMR 2.06(2)(f)1 through 2.06(2)(f)9. inclusive.

(i) Vent Pipe and Fittings Above Ground.
1. All materials listed under 284 CMR 2.06(2)(g)1 through 2.06(2)(g)11 inclusive, with one exception. When using galvanized wrought iron or steel pipe (248 CMR 2.06(g)8), the pipe size restriction does not apply.
2. Galvanized wrought or galvanized steel pipe not lighter than schedule 40, with cast iron or malleable iron screw or grooved end fittings, plain or galvanized.

(j) Water Service Piping (Outside Building). The materials used shall be those specified by each City or Town.

(k) Water Distribution Piping Below Ground (Inside Building).
1. All materials listed in 248 CMR 2.06(2)(j)1, 2.06(2)(j)2, and 2.06(2)(j)3.
2. Type K or L hard drawn copper tubing, incised marked with cast brass fittings.
3. Copper alloy tubing "Heavy" weight conforming to ASTM Standard, color coded aqua and incised marked as "Heavy" with cast brass fittings.
4. Copper core preinsulated cement pressure pipe PVC coated.

(l) Water Distribution Piping Above Ground (Inside Building).
1. Iron size brass or copper pipe with cast brass fittings.
2. Type K, L, or M hard drawn copper tubing, incised marked, with cast brass or wrought copper fittings.
3. Grades H, G, SL, or SM copper coated stainless steel conforming to ASTM Standard, manufactured of Type 430 or 439 stainless steel, plainly marked in conformance with 248 CMR 2.06(2)(p), with cast brass or wrought copper fittings.
4. Copper alloy tubing "Heavy" and "Standard" weight incised marked, color coded aqua and conforming to ASTM Standard, with cast brass or wrought copper fittings.
5. Exposed galvanized wrought iron or steel pipe and fittings. This material may also be used for large size water mains and sprinkler standpipes that also serve as the potable supply, when pipe and fittings are end grooved to be joined with an approved split and bolted galvanized steel coupling with gasket.
6. CPVC (Chlorinated Polyvinyl Chloride) pipe and fittings for hot and cold water distribution in the dwelling portion only, of residential dwellings, multiple family dwellings, hotels, motels, inns, condominiums and similar buildings six (6) stories or sixty (60) feet in height. This material shall not be used within twenty-four (24) inches of any connection to a hot water tank as

2.06: continued

defined in Section 17 of Chapter 142 M.G.L.

7. Mechanical grooved pipe couplings and fittings for use with galvanized wrought iron pipe or galvanized steel pipe on water supply systems under operating conditions not to exceed 230°F. temperature. Coupling housings and fittings shall be cast of malleable iron as described ASTM A-47. Elastomeric gasket for coupling shall have properties as designated by ASTM D-2000.

8. Polybutylene (PB) tubing and celcon, delrin, polybutylene or brass fittings for hot and cold water distribution in single family homes. This material shall not be used closer than twenty four (24) inches to any connection with a gas tank type water heater and shall not be allowed on a hot water system supplied by a coil type (tankless or instantaneous) hot water heater. All tubing and fittings listed or referred to shall comply fully to its respective and regulating standard in Table 1 of 248 CMR 2.06 unless otherwise approved by the board as provided for under 248 CMR 2.06(2)(t).

(m) Pipe, Fittings and Gaskets.

1. Any pipe, fittings, gaskets or other materials listed or referred to in this 248 CMR 2.06(2), or other sections of this Code, shall comply fully with its respective and regulating standard in Table 1 in 248 CMR 2.06, unless otherwise approved by the Board as provided for under 248 CMR 2.06(2)(t).

2. The resilient gasket specified for use on cast iron soil pipe, in addition to complying with the standard in Table 1 in 248 CMR 2.06, shall be marked as follows: The exposed lip shall be marked clearly and legibly to include,

3. Manufacturer's name and/or registered trade-mark,

4. Neoprene,

5. Date of manufacture,

6. ASTM standard,

7. Gaskets for service weight soil pipe shall bear the letters "SV" on the exposed lip,

8. Gaskets for extra heavy soil pipe shall bear the letters "XH" on the exposed lip.

(n) PVC Plastic Pipe and Fittings.

1. PVC, Polyvinyl Chloride Pipe and Fittings, Schedule 40, for residential dwellings, hotels, motels, inns, condominiums and similar buildings six (6) stories or sixty (60) feet in height, and also provided that it shall be used only for the drains, wastes, and vents that serve the sanitary or storm system for beauty parlors, barber shops and photo-labs of such building. Pipe and Fittings shall be manufactured from Type I, Polyvinyl Chloride (PVC) materials having a deflection temperature of 169°F under a load of 264 psi when tested in accordance with ASTM D-648. The materials shall be classified as self-extinguishing when tested in accordance with ASTM D-635 and have a flame-spread rating of 0-25 when tested in accordance with ASTM E-84. Pipe shall also meet the requirements of ASTM, CS, and/or NSF Standards. Independent laboratory tests showing conformance with the foregoing shall be submitted when requested.

2. Identification of Pipe. The pipe shall be in light color such as beige, buff, grey, white, cream, etc. and shall be marked in accordance listed standard. The following markings shall appear on two (opposite) sides of the pipe: Listed Standards: Schedule 40, Size, PVC, DWV-NSF stamp of approval, Manufacturer's name and/or registered trade mark, Type and Grade.

3. Identification of Fittings. Fittings shall be in light color as for pipe and shall bear the following markings by molding on the body or hub: Manufacturer's name and/or registered trade mark, NSF-DWV stamp of approval, PVC -- 1, Size.

4. Transition Fittings. Fittings used to connect PVC to other approved materials shall meet the proper standard and comply

2.06: continued

with the requirements of 248 CMR 2.06(2)(n)3.

5. Installation.

a. Solvent Welded Joint. Clean joining surfaces of pipe and fitting with cleaner. With a natural bristle brush 1" or larger, apply a heavy coat of solvent cement to the pipe joining surface and then a light coat to the socket joining surface. Immediately insert the pipe to the full socket depth while rotating the pipe or fitting one-quarter turn to insure even distribution of solvent cement. Wipe excess solvent cement from the outside of the pipe at the shoulder of the fitting. Do not turn pipe spigot in the socket while wiping. If a fillet or bead of solvent cement is not visible after a joint is assembled, a heavier coat of solvent cement should be used on the pipe spigot. The assembly can be handled with care within two minutes. Do not attempt to adjust the joint after the solvent cement has set or damage will result.

Pipe and fittings conforming to these standards will normally have an interference fit. The interference fit socket maintains pressure between the joining surfaces during the solvent cementing process. Fittings that do not have an interference fit shall have not more than 0.009" clearance to produce strong watertight joints.

b. Threaded Joints. Used for connecting PVC-DWV pipe to other materials. When a threaded joint is required do not thread the pipe, but use the proper PVC male or female threaded adapter. Threaded joints in a DWV system are used for trap connections and clean out plugs.

6. The solvent cement shall conform to the requirements of ASTM D2564-67 or CS 272-65 latest issue. The cleaner is a solvent that has a limited effect on PVC but will remove dirt and grease. The solvent cement shall be labeled with the NSF Seal of Approval.

7. Supports. Conventional pipe clamps, brackets or strapping that have a bearing width of 3/4 inch or more are suitable supports. Supports for horizontal runs of pipe 1 1/2 inches or less in diameter shall be at 3 foot centers as a maximum. Supports for larger diameters shall have a maximum spacing at 4 foot centers. Trap arms shall be supported at the trap discharge. Vertical pipes shall be supported at each story height but not more than 10 foot intervals and elsewhere as required to maintain alignment. All supports shall permit expansion and contraction of the pipe without binding. Horizontal piping shall be supported at each change of direction.

8. Thermal Expansion. Thermal expansion of PVC pipe occurs at the rate of approximately 3/8" per 10' length per 100°F temperature change. In a DWV system an expansion allowance of 1/2" per 10' length of pipe is required. Expansion fittings utilize a rubber o-ring that should be lubricated with water pump grease, petroleum jelly or other water-resistant grease to facilitate assembly. Protect the operating end of the expansion fitting from dirt by means of a thin plastic, rubber or cloth sleeve.

Expansion joints shall be provided between every other branch interval up to and including six (6) stories in a convenient location and on horizontal runs exceeding twenty (20) feet. Expansion joints shall not be required underground.

Expansion fittings shall be installed with operating end upstream and solvent welded to the next downstream pipe or fitting. The expansion joint shall be set for maximum expansion or contraction based on the installation temperature. The expansion joint shall be set for maximum expansion or contraction based on the installation temperature.

9. Roof Flashing. PVC-DWV pipes through the roof shall be made weather tight with an approved flashing.

2.06: continued

10. Lead Joints. PVC-DWV pipe shall be connected to cast iron soil pipe hubs in the usual manner using oakum and at least 1-inch of molten lead. Caulk the joint along the inside and outside edges after it has cooled for 4 minutes.

11. Sleeving. All pipes passing through concrete floor slabs or concrete walls shall be provided with sleeves having an annular space of one inch between pipe and sleeve. Pipes passing through concrete slabs on grade shall be also provided with a sleeve having an annular space of one inch between pipe and sleeve.

12. Trench Installations. Prepare a smooth, uniformly compacted trench bottom using either granular material or finely divided soil free of stones. Place pipe to proper line and grade with continuous bearing on the bottom quadrant along its full length. Using granular material or finely divided soil, compact backfill around the pipe and at least 6" over the top of the pipe. Do not permit large stones or pieces of earth to be dropped into trench when completing the backfilling. The requirements of the above four sentences shall be the responsibility of the applicant for the plumbing permit.

13. Installation Through Fire-Rated Walls. When PVC-DWV pipe passes through a fire wall, the pipe shall be enclosed in a closefitting metal sleeve extended 20 inches on each side of the wall. The sleeve shall be 18 gauge (.040 in.) or heavier. The space between the sleeve and the wall opening shall be firestopped by packing with an acceptable non-combustible filler. Alternate procedures for fire-stopping may be used if they have been tested and proven satisfactory in protecting the fire-rating of the wall system. When closet connections penetrate fire-walls, sanitary bends and connecting piping between water closets and riser fittings shall be acceptable metal material.

(o) ABS Plastic Pipe and Fittings.

1. ABS-DWV (Acrylonitrile-Butadiene-Styrene) pipe and fittings, Schedule 40, for residential dwellings, hotels, motels, inns, condominiums and similar buildings six (6) stories or sixty (60) feet in height, and also for beauty parlors, barber shops and photolabs, provided that it shall be used only for the drains, wastes, and vents that serve only the sanitary or storm system of such building.

2. ABS-DWV pipe and fittings shall be installed using the same methods and requirements as stated in 248 CMR 2.06(2)(n)5. and 248 CMR 2.06(2)(n)7. through 2.06(2)(n)13., except that expansion joints are not required and an ABS solvent recommmended by the manufacturer that meets the required standard shall be used for solvent welding or cementing in connecting the ABS materials.

NOTE --- CAUTION! When using cleaners and solvents for plastics always follow directions carefully and have adequate ventilation. Use PVC fittings ONLY wth PVC pipe --- and ABS fittings ONLY with ABS. NEVER use PVC solvent on ABS or ABS solvent on PVC.

3. Identification of Pipe and Fittings. The pipe and fittings shall be black in color and shall be marked in accordance with listed standard. The following markings shall appear on two (opposite) sides of the pipe: ABS-DWV Schedule 40 and the listed standard, NSF-DWV stamp of approval, Manufacturer's name and/or registered trade mark, Type, Grade and Size.

4. Transition Fittings. Fittings used to connect ABS-DWV to other approved materials shall meet the proper standard and comply with the requirements of 248 CMR 2.06(2)(o)3.

(p) Stainless Steel Tube Marking. Stainless steel tubing in conformance with ASTM designated standard, Type 430 or Type 439, plainly marked as follows:

1. Tubing Grade H or SL color coded blue.

2.06: continued

2. Tubing Grade G or SM color coded red.
3. Marked at intervals no greater than three (3) feet in length in letters not less than 1/8 inch in height, with the manufacturer's name and/or registered trade mark, the ASTM designation nominal diameter and grade.

The name of the manufacturer shall be permanently incised in each tube at intervals not greater than eighteen (18) inches in length.

(q) Urinal Wastes. Urinal branch and fixtures wastes shall be of extra heavy cast iron soil pipe and fittings with caulked joints, threaded cast iron pipe with cast iron drainage fittings, or iron size copper or brass pipe with cast brass drainage fittings. Resilient gaskets shall not be used on urinal wastes. PVC and ABS plastic pipe and fittings may be used only in residential type buildings.

(r) Sumps and Tanks for Sewage. All sumps and tanks for receiving sewage to be removed by mechanical or ejector methods, shall be constructed as follows:

1. Concrete. Three (3) inch minimum wall.
2. Cast Iron. Minimum 1/4 inch thickness.
3. Steel. Minimum 3/8 inch thickness for above ground. For below ground installation it shall be encased in concrete at least three (3) inches thick.
4. Fiberglass. Reinforced polyester resin glass fibers, complying with ANSI listed standards.

(s) Single Stack Sanitary Drainage System. An engineered designed single stack sanitary drainage system, employing the use of de-aerator and deaerator fittings, designed in compliance with CDA 409-70 revised and ANSI Standard B16.32-73, may be used in buildings provided the following requirements are met:

1. Every such system shall be designed or engineered by a qualified person, and plans of such system shall bear the stamp of approval by the CDA and the Board.
2. Piping material shall be Type K, L, M, or DWV hard drawn copper tubing.
3. All fittings shall be made of cast brass or drawn wrought copper and must be of DWV design.
4. No part of such system shall receive the waste from urinals.

(t) Alternate Materials, Methods, and Systems. The provisions of this Code are not intended to prevent the use of materials, methods or systems that are not specifically authorized or prescribed by this Code, provided such alternate materials, methods and systems can meet the standards, use and intent of this Code and are approved by the Board.

The Board shall require sufficient evidence and tests to substantiate any and all claims that such alternate or unauthorized materials, methods or systems are of such design and quality as to be suitable, safe and sanitary for the use intended, and is equivalent in quality, strength, effectiveness, durability and safety to the purpose intended of this Code.

Any tests requested by the Board, for the purpose of verifying claims relating to alternate materials, methods or systems, shall be made by an approved agency at the expense of the applicant. The Board may, at any time, request tests to be repeated, if in their opinion there is reason to believe that an approved alternate material, method or system no longer conforms to the requirements on which their approval was based. Should additional tests prove nonconformance of such alternate material, method, or system, any prior approval by the Board will be rescinded immediately.

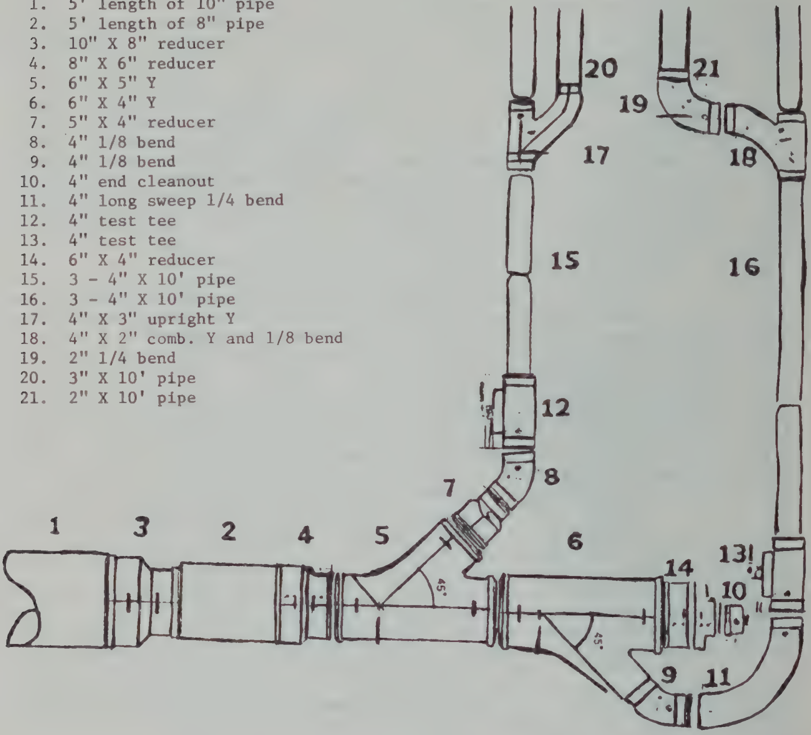
Test Procedure. Tests shall be made in accordance with generally recognized and accepted standards, where such exist, and where none exist the Board shall specify the test procedure.

Permanent Record. A record, open to inspection by the public, shall be maintained in connection with each approval granted under 248 CMR 2.06.

2.06: continued

FIGURE I

NO-HUB COUPLING TEST CONFIGURATION (NOT TO SCALE)



1. 5' length of 10" pipe
2. 5' length of 8" pipe
3. 10" X 8" reducer
4. 8" X 6" reducer
5. 6" X 5" Y
6. 6" X 4" Y
7. 5" X 4" reducer
8. 4" 1/8 bend
9. 4" 1/8 bend
10. 4" end cleanout
11. 4" long sweep 1/4 bend
12. 4" test tee
13. 4" test tee
14. 6" X 4" reducer
15. 3 - 4" X 10' pipe
16. 3 - 4" X 10' pipe
17. 4" X 3" upright Y
18. 4" X 2" comb. Y and 1/8 bend
19. 2" 1/4 bend
20. 3" X 10' pipe
21. 2" X 10' pipe

(u) Pressure and Leak Test Procedure for Stainless Steel Couplings Use on Cast Iron Hubless Soil Pipe.

1. Every manufacturer shall perform the tests as outlined in these provisions and acceptable to the Board for the purpose of determining liquid and/or gas leaks for pressures which may exist in a sanitary and/or storm drainage system.

Such test shall be performed by an approved testing laboratory in the Commonwealth of Massachusetts at the expense of the manufacturer and at a location approved by the Board.

The testing laboratory shall give at least two weeks advance notice to the Board of the date scheduled for the test.

2. The test shall be conducted with hubless pipe and fittings manufactured in conformance with the provisions of CISPI Standard Specification 301-78 or latest issue, and using the minimum pipe and maximum fitting tolerances that are allowed by such standard. Joints shall be assembled in accordance with the manufacturer's instructions.

3. The test shall be for an eight hour period of time under a thirty (30) foot hydrostatic head of water and, at a P.S.I. of thirteen (13) pounds and shall show no visible signs of leakage.

2.06: continued

4. The test assembly shall employ gauges at each end with means of expelling air and the gauges shall be graduated so that, at maximum test, the indicator on the gauges shall be approximately mid-point on said gauges.
5. The test results shall be certified by the testing laboratory used and also by a Massachusetts registered professional engineer or a registered engineer having a reciprocal agreement with the Board of Professional Engineers for the Commonwealth of Massachusetts.
6. The test assembly and configuration shall employ pipe and fittings listed and as shown on the attached sketch and shall be installed in accordance with the pertinent provisions of the Code.

2.07: Joints and Connections

(1) Types of Joints for Piping Materials.

(a) Brazed or Welded. Every brazed or welded joint shall be made by first cleaning down to the base metal the surfaces to be welded or brazed, applying flux approved for such joints and making the joint with approved brazing alloy.

(b) Burned Lead. Every burned (welded) lead joint shall be lapped and the lead shall be fused together to form a uniform weld at least as thick as the lead being joined.

(c) Calked.

1. Cast Iron Soil Pipe. Every lead calked joint for cast iron bell and spigot soil pipe shall be firmly packed with oakum or hemp and filled with molten lead not less than 1 inch deep and not to extend more than 1/8 inch below the rim of the hub. No paint, varnish, or other coatings shall be permitted on the jointing material until after the joint has been tested and approved. Lead shall be run in one pouring and shall be calked tight.

2. Cast Iron Water Pipe. Every lead calked joint for cast iron bell and spigot water pipe shall be firmly packed with clean, sound asbestos rope, treated paper rope, or other material approved by the Board. The remaining space in the hub shall be filled with molten lead according to the following schedule:

PIPE SIZE	DEPTH OF LEAD
Up to 20 inches	2¼ inches
24, 30, 36 inches	2½ inches
Larger than 36 inches	3 inches

Lead shall be run in one pouring and shall be calked tight.

(d) Expansion. Every expansion joint shall be of approved type and its material shall conform with the type of piping in which it is installed.

(e) Flared.

1. Copper Tubing. Every flared joint for soft-copper water tubing shall be made with fittings meeting approved standards. The tubing shall be expanded with a proper flaring tool.

2. Polybutylene (PB). Every flared joint for Polybutylene (PB) water tubing shall be made with fittings meeting approved standards and shall be done in accordance with manufacturers recommended procedures.

(f) Hot Poured. Hot poured compound for clay or concrete sewer pipe or other materials shall not be water absorbent and when poured against, a dry surface shall have a bond of not less than 100 p.s.i. All surfaces of the joint shall be cleaned and dried before pouring. If wet surfaces are unavoidable, a suitable primer shall be applied. The compound shall not soften sufficiently to destroy the effectiveness of the joint when subjected to a temperature of 160 degrees F. nor be soluble in any of the waste carried

2.07: continued

by the drainage system. Approximately 25 percent of the joint space at the base of the socket, shall be filled with jute or hemp. A pouring collar, rope or other device shall be used to hold the hot compound during pouring. Each joint shall be poured in one operation until the joint is filled. Joints shall not be tested until one hour after pouring.

(g) Mechanical (Flexible or Slip Joint).

1. Asbestos Cement Pipe. Every joint in asbestos cement pipe shall be made with a sleeve coupling of the same composition as the pipe or an approved material meeting these standards, sealed with rubber rings except that asbestos cement perforated pipe shall be made with a sleeve coupling which fits on the spigot end of the pipe.

2. Cast Iron Pipe. Every mechanical joint in cast iron pipe shall be made with a flanged collar, rubber ring gasket and appropriate number of securing bolts or with a preformed molded ring secured by pulling the pipe together in such a way as to compress the molded ring.

3. Clay Pipe. Flexible joints between lengths of clay pipe may be made using approved resilient materials both on the spigot end and in the bell end of the pipe.

4. Concrete Pipe. Flexible joints between lengths of concrete pipe may be made using approved rubber materials both on the spigot end and in the bell end of the pipe.

5. Hubless Cast Iron Soil Pipe. Joints for hubless cast iron soil pipe and fittings shall be made with an approved elastomeric sealing sleeve and stainless steel clamp, clamping screw and housing.

6. Split Couplings. Galvanized couplings made in two or more parts, with compression gaskets, may be used with grooved end pipe and fittings as specified under 248 CMR 2.06.

(h) Plastic.

1. ABS, PVC and CPVC. Every joint in ABS, PVC and CPVC piping, except as specified under 248 CMR 2.13, shall be made with approved fittings by solvent weld connections. Solvent weld connections shall be made only with solvent cement manufactured specifically for the materials to be joined.

2. Polybutylene (PB). All joints shall be made with approved fittings by approved methods. The approved jointing methods are heat fusion, flaring, compression (with approved formed gaskets), insert fittings with copper retaining rings and approved mechanical joints. All joints connecting with other materials are to be made with an approved transition fitting. All jointing methods are to conform with existing standards in Table 1 of 248 CMR 2.06 unless otherwise approved by the Board as provided for under 248 CMR 2.06(2)(t).

(i) Precast. Every precast collar shall be formed in both the spigot and bell of the pipe in advance of use. Collar surfaces shall be conical with side slopes of 3 degrees with the axis of the pipe and the length shall be equal to the depth of the socket. Prior to making joint contact, surfaces shall be cleaned and coated with solvents and adhesives as recommended in the standard. When the spigot end is inserted in the collar, it shall bind before contacting the base of the socket. Material shall be inert and resistant to both acids and alkalies.

(j) Slip. Every slip joint shall be made using approved packing or gasket material, or approved ground joint brass compression rings. Ground joint brass connections which allow adjustment of tubing but provide a rigid joint when made up shall not be considered as slip joints. Slip joints may be used on the house side of the trap only.

2.07: continued

(k) Soldered or Sweat. Every soldered or sweat joint for tubing shall be made with approved fittings. Surfaces to be soldered or sweated shall be properly cleaned and reamed. The joints shall be properly fluxed and made with approved solder. Joints in copper water tubing shall be made by appropriate use of approved brass or wrought copper water fittings, properly sweated or soldered together.

(l) Threaded. Every threaded joint shall conform to American National Taper Pipe Thread. All burrs shall be removed. Pipe ends shall be reamed or filed out to size of bore, and all chips shall be removed. Pipe joint cement and paint shall be used only on male threads.

(m) Unions.

1. Drainage System. Unions may be used only in the trap seal or on the inlet side of the trap. Unions shall have metal-to-metal ground seats.

2. Water-Supply System. Unions in the water-supply system shall be metal-to-metal with ground seats.

(n) Wiped. Every joint in lead pipe or fittings, or between lead pipe or fittings and brass or copper pipe, ferrules, solder nipples, or traps, shall be full wiped joints. Wiped joints shall have an exposed surface on each side of a joint not less than 3/4 inch and at least as thick as the material being jointed. Wall or floor flange lead-wiped joints shall be made by using a lead ring or flange placed behind the joints at wall or floor. Joints between lead pipe and cast iron, steel, or wrought iron shall be made by means of a calking ferrule, soldering nipple, or bushing.

(2) Types of Joints Between Different Piping Materials.

(a) Cast Iron to Copper Tubing. Every joint between cast iron and copper tubing shall be made by using a brass calking ferrule and properly sweating the copper tubing to the ferrule.

(b) Cast Iron to Vitrified Clay. Every joint between cast iron piping and vitrified clay piping shall be made either of hot poured bitumastic compound or by a preformed bituminous ring. This ring shall, after ramming, completely fill the annular space between the cast iron spigot and the vitrified clay hub.

(c) Copper Tubing to Threaded Pipe Joints. Every joint from copper tubing to threaded pipe shall be made by the use of brass adapter fittings. The joint between the copper pipe and the fitting shall be properly sweated or soldered, and the connection between the threaded pipe and the fitting shall be made with a standard pipe size screw joint.

(d) Lead Cast Iron, Wrought Iron, or Steel. Every joint between lead and cast iron, wrought iron, or steel pipe shall be made by means of wiped joints to a calking ferrule, soldering nipple, bushing, or by means of a mechanical adapter.

(e) Threaded Pipe to Cast Iron. Every joint between wrought iron, steel, or brass, and cast iron pipe shall be either calked or threaded or shall be made with approved adapter fittings.

(f) Special Joints and Connections. Unless specifically stated in this Section or other sections of this Code, different piping materials shall be joined or connected to in a manner and by use of adapters, transition fittings, prefabricated sealing ring or sleeve, as approved by the Board.

(g) ABS or PVC Plastic to Other Materials.

1. Threaded Joints. ABS or PVC DWV joints when threaded shall use the proper male or female threaded adapter. Only approved thread tape or lubricant seal or other approved material as recommended by the manufacturer shall be used.

2. Cast Iron Hub Joints. Joints shall be made by caulking with lead and oakum or by use of a compression gasket that is compressed when the plastic pipe is inserted in the cast iron hub end of the pipe. No adapters are required for this connection.

2.07: continued

3. Cast Iron Spigot Ends -- Schedule 40 Pipe -- Copper Tube. Joints where the outside diameter of the two pipes and/or fittings to be joined are the same, may be joined with an approved elastomeric sealing sleeve and stainless steel clamp, clamping screw and housing.

(3) Connections Between Drainage Piping and Certain Fixtures. Every Connection between drainage pipes and water closets, floor outlet service sinks, pedestal urinals, and earthenware trap standards or other fixtures with floor outlet, shall be made with brass, wrought copper, hard lead, iron or plastic flanges, that are caulked, soldered, bolted to the flanged connection, with an approved gasket, washer or setting compound between the fixture and the flange. Only brass or stainless steel nuts and bolts shall be used. The floor flange shall be fastened to a structurally firm base. The use of commercial putty or plaster as a setting compound is prohibited.

(a) Schedule 80 PVC or ABS threaded nipples may be used to connect water closets and urinals to carriers of such fixtures.

(4) Tightness. Joints and connections in the plumbing system shall be gastight and watertight for the pressure required by test, with the exceptions of those portions of perforated or open joint piping which are installed for the purpose of collecting and conveying ground or seepage water to the underground storm drains.

(5) Waterproofing of Openings.

(a) Joints at the roof around roof drains and vent pipes, shall be made watertight by the use of lead, copper, aluminum, or other approved flashing or flashing materials.

(b) Caps for extended roof flanges shall be made to fit snug to the inside circumference of the vent pipe. Said cap shall not decrease the pipe opening by more than the thickness of the cap material.

(c) Exterior wall openings shall be made watertight.

(6) Increasers and Reducers. Where different sizes of pipes, or pipes and fittings, are to be connected, the proper sizes of increasing or reducing fittings shall be used.

2.08: Traps and Cleanouts

(1) Fixture Traps.

(a) Separate Traps for Each Fixture. Each plumbing fixture shall be separately trapped by a water seal trap placed as close as possible to the fixture outlet. The developed distance from the fixture outlet to the trap weir shall not exceed 24 inches. No fixture shall be double trapped. Exceptions to the separate trapping requirements are as follows:

1. Fixtures having integral traps,
2. A combination plumbing fixture may be installed on one trap provided one compartment is not more than 6 inches deeper than the other and the waste outlets are not more than 30 inches apart,
3. One trap may be installed for a set of not more than three single compartment sinks, laundry trays, or lavatories, immediately adjacent to each other in the same room, and the trap is centrally located when three such fixtures are installed. Center to center of waste outlets shall not exceed thirty inches.
4. The waste for a domestic type dishwasher may be separately trapped, or may connect into the inlet side of a food waste grinder, or be connected with a "Y" fitting between a domestic kitchen sink or food waste grinder outlet and the trap inlet.

(b) Size of Fixture Traps. Fixture trap size (nominal diameter) shall be sufficient to drain the fixture rapidly and in no case less than given in Table 1 in 248 CMR 2.08 -- Minimum Size of Fixture Traps for Different Type Plumbing Fixtures. No trap shall be larger than the drainage pipe into which it discharges.

2.08: continued

TABLE 1
MINIMUM SIZE OF FIXTURE TRAPS

Plumbing Fixture	Trap Size in Inches
Bathtub (with or without overhead shower)	1½
Bidet	1½
Clothes washer (domestic)	1½
Combination sink and wash (laundry) tray	1½
Combination sink and wash (laundry) tray with food waste grinder unit	*1½
Dental unit or cuspidor	1½
Dental Lavatory	1½
Drinking fountain	1½
Dishwasher, commercial	2
Dishwasher, domestic	1½
Floor drain	2
Food waste grinder	1½
Kitchen sink, domestic, with food waste grinder unit	1½
Kitchen sink (2 compartments)	1½
Kitchen sink, domestic	1½
Lavatory, common	1½
Lavatory (barber shop, beauty parlor or surgeon's)	1½
Lavatory, (multiple type) (wash fountain or washsink)	1½
Laundry tray (1 or 2 compartments)	1½
Shower stall	2
Sink (surgeon's)	1½
Sink (flushing rim type, flush valve supplies)	3
Sink (service type with floor outlet trap standard)	3
Sink (service trap with P trap)	2
Sink, commercial (pot, scullery, or similar type)	2
Sink, commercial (with food grinder unit)	2

*Separate trap required for wash tray and separate trap required for sink compartment with food waste grinder unit.

2.08: continued

(c) Prohibited Traps. The following type traps are prohibited:

1. Traps which depend upon moving parts to maintain their seal,
2. Bell traps,
3. Crown vented traps,
4. Separate fixture traps which depend on interior partitions for their seal,
5. Full "S" traps.

(d) Design of Traps. Fixture traps shall be self scouring and shall have no interior partitions except where such traps are integral with the fixture. Slip joints or couplings may be used on the trap inlet or within the trap seal of the trap if a metal-to-metal ground joint is used. Each fixture trap, except a trap that is cast integrally or in combination with the fixture in which the trap seal is readily accessible or except when a portion of the trap is readily removable for cleaning purposes, shall have an accessible cleanout plug of ample size that is protected by the water seal.

(e) Fixture Trap and Connection Material (HOUSE SIDE).

1. Fixture traps shall be made of cast brass, with a wall thickness of not less than .01 inches, or of schedule 40 ABS or PVC.
2. Cast iron traps may be used in connection with floor drains, slop sinks, building (house) traps, conductors (when necessary) and similar installations, weights and thicknesses to comply with like materials under 248 CMR 2.06.
3. Slip nuts used to connect fixture and appliance outlet piping to the trap, shall be of brass, copper or schedule 40 ABS or PVC.
4. Tubing traps made of brass or copper are permitted when not less than 17 gauge thickness.
5. Strainers, P. O. plugs, tail pieces, waste arms, bathtub wastes and overflows, and any other similar fixture to trap connection, when of metal, shall be made of brass or other approved non-corrosive metal, not less than 17 gauge thickness.
6. All items listed in 248 CMR 2.08(1)(e)4. and 2.08(1)(e)5. above, when made of ABS or PVC are permitted, provided that they all comply with Proposed Standard ASTM D-20 for PVC and ABS Tubular Traps and Fittings and any amendments or additions made thereto, except that Paragraph 7 of the above proposed standard is replaced with the following:
7. Marking. Each trap and/or fitting shall be marked in letters not less than 1/8 inch high, in a contrasting color, as follows: ASTM D-20; NSF DWV (Standard 14); Manufacturer's name or registered trade mark; Size; Tubular (following the letters ABS or PVC).

(f) Trap Seal. Each fixture trap shall have a liquid seal of not less than 2" and not more than 4 inches, except where for special conditions, a deeper seal may be required.

(g) Trap Setting and Protection. Traps shall be set level with respect to their water seals and, where necessary, shall be protected from freezing.

(h) Building Traps. Building (House) traps shall not be installed, unless in the opinion of the Inspector of Plumbing they are necessary. Each building trap when installed shall be provided with a cleanout and with a relieving vent or fresh air intake which need not be larger than one-half the diameter of the drain to which it connects.

(i) Acid Resisting Traps. Where a vitrified-clay or other brittleware, acid-resisting trap is installed underground, it shall be embedded in concrete extending 6 inches beyond the bottom and sides of the trap.

(2) Drainage Pipe Cleanouts.

(a) Location. Cleanouts shall be not more than 50 feet apart in

2.08: continued

horizontal drainage lines of 4-inch nominal diameter or less and not more than 100 feet apart for larger pipes.

(b) Underground drainage. Cleanouts, when installed on an underground drain, shall be extended vertically to or above the finished grade level or the cleanout may be extended outside the building.

(c) Change of Direction. Accessible cleanouts shall be installed at each change of direction of the building drain greater then 45 degrees.

(d) Concealed Piping. Cleanouts on concealed piping shall be extended through and terminate flush with the finished wall or floor; or pits or chases may be left in the wall or floor, provided they are of sufficient size to permit removal of the cleanout plug and proper cleaning of the system.

(e) Base of Stacks. A cleanout shall be provided at or near the foot of each vertical storm water conductor, waste or soil stack.

(f) Inaccessible Stack Cleanouts. For buildings with a floor slab, or with less than 18-inch crawl space under the floor or where a stack cleanout is not easily accessible, the following shall be provided in lieu of a cleanout at the base of the stack. The building drain shall be extended to the outside of the building and terminated in an accessible cleanout or an accessible cleanout may be installed in the building drain downstream from the stack not more than 5 feet outside the building wall.

(g) Building Drain at Foundation Wall. There shall be a cleanout on the building drain so located as to provide accessibility in direct line through the building drain to building sewer. If necessary a pit or manhole shall be provided in a location determined by the Inspector of Plumbing. When cast iron soil pipe and fittings are used, the joining methods shall comply with 248 CMR 2.07(1)(c) and shall be installed as shown in sketches in the appropriate sections of this Code.

(h) Direction of Flow. Every cleanout shall be installed so that the cleanout opens in the direction of the flow of the drainage line or at right angles thereto.

(i) Cleanout Size. Cleanouts shall be of the same nominal size as the pipes up to 4 inches and not less than 4 inches for larger piping.

(j) Cleanout Clearances.

1. Large Pipe - 18 Inch Clearance: Cleanouts on 3 - inch or larger pipes shall be so installed that there is a clearance of not less than 18 inches for the purpose of rodding.

2. Small Pipe - 12 Inch Clearance: Cleanouts smaller than 3 inches shall be so installed that there is a 12-inch clearance for rodding.

(k) Cleanouts to Be Kept Uncovered. Cleanout plugs shall not be covered with cement, plaster, or any other permanent finishing material. Where it is necessary to conceal a cleanout plug, a covering plate or access door shall be provided which will permit ready access to the plug.

(l) Cleanout Equivalent. A fixture trap or a fixture with integral trap, readily removable without disturbing concealed roughing work, may be accepted as a cleanout equivalent.

(m) Connections to Cleanouts Prohibited. Cleanout openings shall not be used for the installation of any new or additional plumbing, except when approved in writing by the Inspector of Plumbing and where another cleanout of equal access and capacity is provided.

(n) Manholes for Large Pipes. For underground piping over ten (10) inches in diameter, manholes shall be provided and located at every change of size, alignment, grade or elevation and at intervals of not more than three hundred (300) feet except when total length is less than one hundred fifty (150) feet cleanouts may be installed at seventy five (75) foot intervals. Manholes shall conform to current standards and engineering practices.

2.09: Interceptors, Separators and Backwater Valves

(1) Interceptors and Separators.

(a) Interceptors Required. Interceptors shall be provided to prevent the discharge of oil, grease, sand, and other substances, that are harmful or hazardous to the building drainage system, the public sewer, or sewage treatment plant or processes.

(b) Approval of Interceptors.

1. Size, Type and Location. The size (capacity), type, and location of each interceptor, shall be approved by the Inspector and no wastes other than those requiring treatment or separation shall be discharged into any interceptor.

2. All Interceptors to Follow Type Approved. No interceptor shall be installed which does not comply in all respects with the type or model of each size approved.

(c) Separators Required. All commercial storage or repair garages; gasoline stations with grease racks, grease pits, or wash racks or areas; motor vehicle laundries; and all factories where oily and/or flammable liquid wastes are produced, separators and floor drains shall be installed, into which all oil bearing, grease bearing, and/or flammable wastes shall be discharged before emptying into the building drainage system or other point of disposal.

(d) Approval of Separators.

1. Size, Type and Location. The size (capacity), type, and location of each separator, shall be approved by the Inspector and shall be in conformance with Drawing and Specifications 248 CMR 2.09(1)(d) and no wastes other than those requiring treatment or separation shall be discharged into any separator.

2. All Separators to Follow Type Approved. No separator shall be installed which does not comply in all respects with drawings and specifications shown in the appropriate section of this Code.

3. Municipalities Interconnected with M.D.C. Sewerage System. In all cities and towns, whose sewage disposal is discharging into the Metropolitan District Commission Sewerage System, separator installations shall be inspected and approved by the municipal Inspector and the M.D.C. Authority.

(e) Separation of Liquids. A mixture of light and heavy liquids having different specific gravities, may be treated and then separated in an approved receptacle.

(f) Venting. Interceptors and separators shall be so designed that they will not become air bound, when closed covers are used. Each interceptor shall be properly vented to comply with 248 CMR 2.16 and each separator to comply with Drawing and Specification (Figure 1 in 248 CMR 2.09).

(g) Accessibility. Each interceptor and separator shall be so installed that it is readily accessible for removal of cover, servicing and maintenance. Need for use of ladders or moving of bulky objects in order to service interceptors or separators shall constitute a violation of accessibility.

(h) Maintenance. Interceptors and separators shall be maintained in efficient operating condition by periodic removal of accumulated grease, scum, oil, or other floating substances, and solids deposited in the bottom of the interceptor or separator. Grease traps shall not be required on automatic dishwashers.

(2) Grease Interceptors.

(a) A grease interceptor shall be installed in the waste line leading from sinks, drains or other fixtures in the following establishments: Restaurant, cafeteria, hotel, hospital, institutional, factory, club, and other commercial kitchens; food and meat packing and processing establishments; super markets, bakeries, and other establishments where grease can be introduced into the drainage system in quantities that can cause line stoppage or hinder sewage disposal. Refer to 310 CMR 15.00 relative to grease removal at installations from which large quantities of grease can be expected to discharge.

2.09: continued

(b) Testing and Rating. Grease interceptors shall not be installed unless tested, rated and bear the seal of acceptance of P.D.I., or approved by the Board.
(c) Capacity. Installed grease interceptors shall have a grease retention capacity of not less than two (2) pounds for each gpm of flow.
(d) Rate of Flow Controls. Grease interceptors shall be equipped with devices to control the rate of water flow through the interceptors so that it does not exceed the rated flow of the interceptors.
(e) Food Waste Grinders. The waste from food waste grinders (garbage disposers) shall not discharge to the drainage system through a grease interceptor.
(f) Water Cooled Interceptors. The use of water cooled grease interceptors is prohibited.
(g) Interceptors Not Required. Grease interceptors are not required for individual dwelling units or any private living quarters.

(3) Special Use Installations.
(a) Sand Interceptors -- Floor Drains. Wherever a floor drain discharges through an oil and gasoline separator, the floor drain shall be equipped with an approved sediment and sand arrestor basket, or the floor drain shall discharge through a sand interceptor. Multiple floor drains may discharge into one sand interceptor.
(b) Sand Interceptors -- Commercial Establishments. Sand and similar interceptors for heavy solids shall be so designed and located as to be readily accessible for cleaning, and shall have a water seal of not less than 6 inches.
(c) Laundries (Commercial laundries known as Laundromats are excluded from this paragraph). Commercial laundries shall be equipped with an interceptor having a wire basket or similar device, removable for cleaning, that will prevent passage into the drainage system of solids 1/2 inch or larger in size, string, rags, buttons, or other materials detrimental to the public sewerage system.
(d) Bottling Establishments. Bottling plants shall discharge their process waste into an interceptor which will provide for the separation of broken glass or other solids, before discharging liquid wastes into the drainage system.
(e) Slaughter Houses. Slaughtering room and dressing room drains shall be equipped with interceptors approved by the Plumbing Drainage Institute which shall prevent the discharge into the drainage system of feathers, entrails, and other materials likely to clog the drainage system.

(4) Backwater Valves.
(a) Fixture Subject to Backflow. A backwater valve shall be installed in a branch of the building drain which receives the discharge from a fixture or group of fixtures that in the opinion of the Inspector of Plumbing is subject to reverse flow or backpressure.
(b) Materials for Backwater Valves. Backwater valves shall have all bearing parts of corrosion-resistant material.
(c) Construction of Backwater Valves. Backwater valves shall be constructed so a mechanical seal against backflow will be provided.
(d) Diameter of Backwater Valves. Backwater valves, when fully opened shall have an effective opening not less than that of the pipes in which they are installed.
(e) Location of Backwater Valves. Backwater valves shall be installed so their working parts will be readily accessible for service and repairs.
(f) Approval of Backwater Valves. In lieu of an acceptable standard for backwater valves, they shall be approved by the Board under 248 CMR 2.06(2)(t).

2.09: continued

(5) Approval of Special Designed Interceptor or Separator. Before installing any special type or design of an interceptor or separator, detailed drawings, including all pertinent information shall be submitted to the Board for approval under 248 CMR 2.06(2)(t).

2.10: Plumbing Fixtures

(1) Fixture Materials and Quality. Plumbing fixtures shall be constructed from approved materials, have smooth and impervious surfaces and be free from defects, and, except as permitted elsewhere in this Code, shall conform to the applicable standard listed in Table 1 in 248 CMR 2.06.

(2) Materials for Special Use Fixtures. Materials for special use fixtures not otherwise provided for in this Code, may be stainless steel, soapstone or chemical stoneware, plastic, or may be lined with lead, copper-base alloy, nickel-copper alloy, corrosion-resisting steel, or other materials especially suited for the use for which the fixture is intended. Before any special use fixture is installed, it must first be approved by the Board under 248 CMR 2.06(2)(t).

(3) Overflows.
(a) Design. When any fixture is provided with an overflow, the waste shall be so arranged that the standing water in the fixture cannot rise in the overflow when the stopper is closed or remain in the overflow when the fixture is empty.
(b) Connection. The overflow from any fixture shall discharge into the drainage system on the inlet or fixture side of the trap, except that the overflow from a flush tank serving a water closet or urinal shall discharge only into the fixture served.

(4) Installation.
(a) Cleaning. All fixtures must be installed so as to afford easy access for cleaning both the fixture and the area about it.
(b) Joints. Where fixture comes in contact with wall and floors, the joint shall be watertight.
(c) Securing Fixtures. Floor outlet and wall hung fixtures shall be rigidly secured to the floor or wall by screws or bolts, or other approved methods.
(d) Wall-hung Bowls. Wall hung water closet bowls shall be rigidly supported by a concealed metal supporting member so that no strain is transmitted to the closet connection, or the wall.
(e) Setting. Fixtures shall be set level and in proper alignment with reference to adjacent walls.

(5) Prohibited Fixtures. A pan, valve, plunger, offset, washout, frostproof latrine, or other closet which has an invisible seal or an unventilated space, or water closet that has walls which are not thoroughly washed at each discharge is prohibited. Any water closet which might permit siphonage of the contents of the bowl back into the tank, is prohibited. Trough urinals and floor stall urinals are prohibited. Wall hung urinals connected to an exposed trap, are prohibited.

(6) Water Closets.
(a) Public Use. A water closet for public use shall be of the elongated type.
(b) Flushing Device. Water closet tank shall have sufficient capacity to flush properly the water closet bowl with which it is connected.
(c) Float Valve and Ballcocks. A float valve or ballcock in a water closet flush tank shall be of anti-siphon design and shall provide sufficient water to refill the trap seal in the water closet bowl.

2.10: continued

(d) Flushometer Valves. A flushometer valve shall be so installed that it will be readily accessible for repairing. When the valve is operated, it shall complete the cycle of operation automatically opening and closing positively under the service pressure. At each operation the valve shall deliver water in sufficient volume and at a rate that will thoroughly flush the fixture and refill the fixture trap. Means shall be provided for regulating the flushometer valve flow. Not more than one (1) fixture shall be served by a single flushometer valve. Protection against backflow shall be provided as specified in 248 CMR 2.14(6).
(e) Seats. A water closet shall be equipped with a seat of smooth non-absorbent material. The seat of a water closet which is provided for public or semi-public use shall be of the open front type.
(f) Water Closets. Water closets with mechanical seals are prohibited unless approved by the board.

(7) Urinals.
(a) Urinal Fixtures. Only pedestal urinals and wall hung urinals with integral traps shall be approved and used. Said urinals shall be flushed only by means of an automatic flushing tank or flushometers equipped with an approved back flow preventer.
(b) Automatic Flushing Tank. A tank which flushes more than one (1) urinal shall be automatic in operation; and shall be of sufficient capacity to provide the necessary water to flush and cleanse properly all urinals simultaneously.
(c) Materials Surrounding Urinals for Public or Semi-Public Use. The floor areas to one (1) foot in front of the urinal lip and one (1) foot on each side of the urinal, and the wall areas to four (4) feet above the floor, shall be finished so as to be non-absorbent. Wood and fiber boards are prohibited in the above noted areas.

(8) Shower Baths, Stalls and Compartments.
(a) Water Supply Riser. Every water supply riser from the shower valve to the shower head outlet, whether exposed or not, shall be securely attached to the structure.
(b) Shower Waste Outlet. Waste outlets, other than those in bathtubs, serving showers shall be at least 2" in diameter and have removable strainers not less than three inches in diameter having strainer openings not less than 1/4 inch in minimum dimension. Where each shower space is not provided with an individual waste outlet, the waste outlet must be so located and the floor so pitched that waste water from one shower does not flow over the floor area serving another shower. Waste outlets shall be securely fastened to the waste pipe making a watertight connection thereto.
(c) Shower Compartments. Shower compartments shall have at least 900 square inches of floor area and be not less than 30 inches in minimum dimension measured from its finished interior dimension as the side of a rectangle, altitude of a triangle or diameter of a circle or other angular shape. The wall area above built-in tubs having installed shower heads and in shower compartments shall be constructed of smooth, noncorrosive, and non-absorbent, waterproof materials to a height not less than 6 feet above the floor level. Such walls shall form a watertight joint with each other and with either the tub, receptor, or shower floor. Waste outlets for individual shower compartments shall be sized 2".
(d) Shower Floors or Receptors. Floors or receptors under shower compartments shall be laid on or be supported by a smooth and structurally sound base. Floors under shower compartments, other than those laid directly on the ground surface or where prefabricated receptors have been provided, shall be lined and made watertight by the provision of suitable shower pans of durable material. Such pans shall turn up on all sides at least above the finished

2.10: continued

threshold level. Pans shall be securely fastened to the waste outlet at the seepage entrance making a watertight joint between the pan and the outlet. Floor surfaces shall be constructed of smooth, noncorrosive, nonabsorbent, and waterproof materials.

(e) Shower Controls.

1. When a flow control valve or shower head designed for tight shut-off is installed on the outlet pipe from a shower control unit, checks shall be provided in the hot and cold water supplies to the unit to prevent by-passing of hot or cold water. The above shall not be required when shower control unit is designed to prevent bypassing.

2. All showers, shower stalls, shower compartments, gang showers, and shower baths, either multiple or single, shall be equipped with an approved adjustable self-cleaning and draining shower head. The water supply to said shower head shall be supplied through an approved individual single handle thermostatic and/or pressure balancing device. The device shall contain means for a maximum temperature setting to prevent water from being delivered from the shower head in excess of 112°F. Said device shall be designed to prevent bypassing and to prevent any sudden temperature changes when valve is set at the desired setting and connected to hot and cold water supply lines that have balanced hydrostatic pressures.

A central type automatic temperature control valve may be used in lieu of individual automatic mixing valves, provided the temperature control valve permits a maximum temperature of 112°F. to the hot water supply of the shower control during all periods when showers are in use. A thermometer is required in the outlet piping of the central control for inspection and adjustment of temperature. Check valves are required on the hot and cold inlets to the central control valve. The automatic temperature control valve described above is a secondary control for hot water supply to shower stations and is in addition to primary control used to maintain the water temperature in the domestic hot water system. When the temperature in the hot water supply piping to shower stations is controlled as described above, individual shower controls may be two-valve type, single valve or any acceptable mixing valve.

3. All automatic temperature control devices shall be adjusted by the installing plumber, prior to the Final Inspection (248 CMR 2.04(11)(c)), to deliver water at a safe and useable temperature, but in no case to exceed 110 to 112 degrees F.

(9) Food -- Waste -- Grinder Units.

(a) Residential or Domestic Food-Waste Grinder-Waste Outlets. Domestic food-waste-grinder units shall be connected to a drain of not less than 1 1/2 inches in diameter.

(b) Commercial-Food-Waste-Grinder Outlets. Commercial food-waste-grinder units shall be connected to a drain of sufficient size to serve the unit, but in no case connected to a drain of less than 2 inches in diameter. Commercial food-waste-grinder units shall be connected and trapped separately from other fixtures or compartments. They shall be separately connected to the stack or main drain.

(c) Water Supply Required. All food-waste-grinder units shall be provided with an adequate supply of water in sufficient flow rate to insure proper functioning of the unit.

(d) Grinder Units Not to Be Connected with Grease Interceptors. No food-waste-grinder unit shall be connected so as to discharge through a grease interceptor.

(10) Drinking Fountains.

(a) Design and Construction. A drinking fountain shall conform to the listed ANSI standard in Table 1 in 248 CMR 2.06.

2.10: continued

(b) Protection of Water Supply. Stream projectors shall be assembled to provide an orifice elevation as specified by ANSI Air Gaps in Plumbing Systems and ANSI Backflow Preventers In Plumbing Systems. See Table 1 in 248 CMR 2.06.

(11) Floor Drains and Area Drains.

(a) Floor Drains.

1. Floor drains shall have integral or separate traps having a minimum water seal of three inches and shall be provided with removable strainers. The floor drain shall be so constructed that it can be readily cleaned, and the drain inlet shall be easily accessible at all times. Floor drains subject to backflow shall be provided with back water valves.

2. Size of Floor Drains. Floor drains shall be of a size to serve efficiently the purpose for which they are intended, but the outlet pipe shall not be less than 2 inches in nominal diameter.

3. Protection Against Loss of Seal. Where floor drain trap seals are subject to evaporation, they shall be provided with a deep seal and with a water supply fed from an approved plumbing fixture or by means of an approved automatic priming device or by other means approved by the Inspector.

(b) Area Drains.

1. Connected to Storm Water Conductor System. All area drains shall be connected to the storm water drainage system. They shall be provided with a trap and back water valve in an accessible location not subject to freezing.

2. Size of Area Drains. Area drains shall be of size to serve efficiently the area for which they are intended, but the outlet pipe shall not be less than 3 inches in nominal diameter.

(12) Dishwashing Machines.

(a) Waste Discharge.

1. Domestic. The waste shall discharge through an approved air gap fitting, the discharge from which shall be immediately increased to a minimum of one (1) inch and connected to comply with 248 CMR 2.08(1)(a)4. *

2. Commercial. Commercial dishwashing machines shall be indirectly connected, except that when the machine is located above or within five (5) feet of a trapped floor drain, the waste may be connected directly to the inlet side of a properly vented floor drain trap; or the machine may discharge waste directly through a connection to the sewer side and immediately adjacent to the floor drain trap, provided the floor drain is not equipped with a backwater valve and the drain line from the machine is properly trapped and vented.

(b) Portable Dishwashers. Portable dishwashing machines (domestic) may discharge over the rim of a properly trapped, wasted and vented fixture.

(13) Automatic Clothes Washing Machine.

(a) Water Supply. A water supply line to an automatic clothes washer shall be protected against backflow by the use of an air gap or a back flow preventer.

(b) Waste Discharge.

1. Domestic Machines. The waste from an automatic clothes washer shall discharge through an air break into a laundry tray or standpipe. The standpipe shall extend to a minimum height

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* Editors Note: The provisions of 248 CMR 2.08(1)(a)4. would appear to make 2.10(12)(a)1. obsolete.

2.10: continued

of thirty (30) inches above the base of the machine and shall be not less than one and one-half (1 1/2) inches in diameter.
2. Laundromats (Commercial). The minimum size of trap and standpipe for commercial type automatic clothes washing machines shall be not less than two (2) inches in diameter, that shall connect to a drain of sufficient size to receive the simultaneous discharge of at least 75% of all machines connected thereto.
3. Commercial and Institutional. The drainage facilities to be provided for commercial and/or institutional laundries shall be approved by the Board.

(14) Multiple Type Lavatory (Wash Sink). Each twenty (20) inch unit of usable length or circumference of a straight-line or circular multiple use lavatory shall be considered equivalent to one lavatory as it affects the drainage and water supply piping sizes and fixture usage requirements; provided hot and cold or tempered water for handwashing is available for each twenty (20) inch interval.

(15) Garbage Can Washers. Garbage can washers shall be separately trapped. The receptacle receiving the wash from garbage cans shall be provided with a removable basket or strainer to prevent discharge of large particles into the building drainage system. Any water supply connection shall be protected against backflow by an air gap or an approved backflow prevention device.

(16) Special Fixtures and Specialties. Water Connections, Baptistries, ornamental and lily pools, aquaria, ornamental fountain basins and similar constructions, when provided with water supplies, shall be protected from back siphonage.

(17) Sacrariums. The waste material from a Sacrarium shall be conducted separately and directly to a drywell in the ground, which shall not be used for any other purpose. In no case shall the waste from a Sacrarium be connected to the building storm, or sanitary waste and vent system. The waste from a Sacrarium shall not be trapped or vented.

(18) Minimum Facilities for Dwellings. Whenever plumbing fixtures are installed, the minimum number of each type of fixture shall comply with the requirements of the State Sanitary Code, Article II, Minimum Standard of Fitness for Human Habitation, 105 CMR 410.00, and shall conform with 248 CMR 2.01(7).

(19) Minimum Facilitities for Building Occupancy Other Than Residential.

(a) Assembly Occupancy (Other than schools, colleges and churches.).

1. Definition of Place of Assembly. Any building designed, constructed, reconstructed, remodeled, altered, used, or intended to be used, for twenty or more persons to assemble therein for any of the following: Dance halls; cabarets; restaurants; including the type of restaurant commonly known as a night club; all places in which alcoholic beverages are sold, or offered for sale, to be consumed on the premises; any room or space used for public or private banquets, feasts, dances, socials, card parties, weddings or religious services except in the case of funerals in private homes; lodge and meeting halls or rooms; skating rinks; gymnasiums; swimming pools; billiard, pool, bowling, and table tennis rooms; halls or rooms used for public or private catering purposes; funeral parlors; recreation rooms; broadcasting studios; school and college auditoriums, and all other places of similar occupancy. Nothing in this paragraph shall apply to single or multiple family dwellings, or to a place

2.10: continued

of incarceration or detention, a convent, a monastery, a church, a synagogue, (or other place of worship), or a schoolhouse.

2. Number of Fixtures Required. The total number of plumbing fixtures required for Buildings classified under 248 CMR 2.10(19)(a) shall be as specified in Table 1 in 248 CMR 2.10.

NON-TEXT PAGE

2.10: continued

TABLE 1
PLUMBING FIXTURES FOR ASSEMBLY OCCUPANCY(1)

Occupancy Load	Minimum Number of Waterclosets	Minimum Number of Lavatories
20 - 50	1	1
51 - 99	2	2
100 - 149	3	3
150 - 200	4	4
201 - 300	5	5
301 - 400	6	6
401 - 1000	7	7
1001 - 1500	8	8
1501 - 2000	9	9
More than 2000	1 per 200	1 per 400

Note: (1) Plumbing fixtures for employees to be included in above table.
(2) When occupancy load is less than 20, refer to Table 5 in 248 CMR 2.10 for employees requirement.
(3) If occupancy is less than 20, there shall be a minimum of one water closet and one lavatory for each sex, to accomodate employees.

3. Credit for Urinals. The number of urinals for men shall be not less than one-third (1/3) of the number of required waterclosets. When provision is made for more than fifty (50) males, a credit of one (1) watercloset will be allowed for each urinal provided.

(b) Churches (And other places of worship). In church buildings, not less than one (1) watercloset shall be provided for each three hundred (300) occupants of each sex; and not less than one (1) lavatory for every two (2) waterclosets provided. In no case shall there be less than one (1) watercloset and one (1) lavatory provided for each sex.

(c) School Occupancy. In a school occupancy, plumbing fixtures shall be provided in accordance with Table 2 in 248 CMR 2.10. Additional lavatories installed in classrooms shall not affect the ratio of lavatories required for general toilet rooms.

(d) Industrial Establishments, Factories, Warehouses, Foundries and Similar Establishments. In every industrial establishment, all toilet room facilities, including the number and type of plumbing fixtures, the floors, walls, windows, ceilings, lighting, ventilation, doors, partitions, design and location of all toilet rooms shall comply with the Rules and Regulations for Toilets in Industrial Establishments as adopted by the Department of Labor and Industries.

1. Separate Facilities. Where persons of both sexes are employed together, separate toilet rooms shall be provided for each sex, and shall be plainly so designated. If a store or similar establishment is less than 500 square feet, only one toilet room shall be required for use by both sexes.

2. Number of Waterclosets and Lavatories Required. The number of shall be provided within reasonable access and in accordance with Table 2 in 248 CMR 2.10.

3. Number of Urinals Required. Where more than ten (10) males are employed urinals shall be provided in the ratio of one (1) urinal to every forty (40) males, based upon the maximum number of persons employed at any one time.

4. Number of Lavatories Required. The number of lavatories, washbowls or sinks shall not be less than one (1) to every thirty (30) persons, based upon the maximum number of persons entitled to use same at any one time. Twenty (20) inches of sink will be considered as an equivalent of one lavatory.

2.10: continued

In special industries or departments where there is undue exposure to poisonous substances or liquids or where the work is especially dirty, one (1) lavatory or sink may be required for every five (5) persons, and in all cases a potable supply of hot and cold water shall be provided.

2.10: continued

TABLE 2

PLUMBING FIXTURES REQUIRED FOR SCHOOLS

Girls' Water Closets		Boys' Water Closets		Boys' Urinals	
Elementary	- 1 per 30 students	Elementary	- 1 per 60 students	Elementary	- 1 per 30 students
Secondary	- 1 per 45 students	Secondary	- 1 per 90 students	Secondary	- 1 per 30 students
Post Secondary	- 1 per 90 students	Post Secondary	- 1 per 180 students	Post Secondary	- 1 per 90 students

Lavatories shall be provided at the ratio of one (1) per sixty (60) students, and each toilet room shall have at least one lavatory. Toilet rooms shall have lavatories at the ratio of one (1) per two (2) water closets and four (4) urinals and each toilet room shall have at least one (1) lavatory, except for kindergarten and primary rooms where the lavatory may be installed in the classroom.

Drinking Fountain - One (1) drinking fountain per 75 students.

Auditoriums and Multi-Purpose Rooms --- When auditoriums and multi-purpose rooms will have community use, additional toilet facilities shall be provided as follows:

For Women: 1 water closet for each 300 seats or majority fraction thereof.
For Men: 1 Urinal for each 400 seats, and
1 water closet for each 600 seats or majority fraction thereof.

Teachers and Employees --- Facilities for teachers and employees shall be in addition to the above.

Kitchen Employees --- Separate facilities shall be provided, to comply with 248 CMR 2.10 (2)(e)

TABLE 3

PLUMBING FIXTURES REQUIRED IN DORMITORIES

1. One (1) toilet for each eight (8) occupants or portion thereof. For males, urinals may be substituted for one half the number of toilets required on the basis of one (1) urinal substituted for one (1) toilet.
2. One (1) wash basin for each eight (8) occupants or portion thereof.
3. One (1) shower or bathtub for each eight (8) occupants or portion thereof.
4. In a room with more than one (1) toilet, each toilet shall be separated by walls or partitions which afford privacy.
5. Toilet, shower and handwash facilities shall be accessible from within the building and shall be so placed as to not require passing through any part of another dwelling unit or rooming unit.
6. One (1) laundry tray for each fifty (50) persons.
7. One (1) slop sink for each one hundred (100) persons.
8. One (1) drinking fountain for each seventy-five (75) persons.

TABLE 3A

PLUMBING FIXTURES REQUIRED IN DETENTION FACILITIES

1. A toilet and handwash sink in each cell in which a person is locked for any part of a twenty-four (24) hour day.
2. The sink shall be connected to the hot and cold water systems.
3. Where individual facilities are not required by number one above, there shall be one (1) toilet and one (1) handwash sink for each six (6) inmates. Urinals may be substituted for one third (1/3) of the required male toilets.
4. There shall be one (1) shower or bathtub for each six (6) inmates.

2.10: continued

(e) Other Establishment Occupancy Requirements. In every establishment, except industrial establishment and establishments where one (1) person is employed or works, plumbing fixtures shall be provided within reasonable access and in accordance with Table 4 in 248 CMR 2.10. Where two (2) or more persons are employed or work, separate waterclosets and lavatories, plainly marked, shall be provided for each sex. The minimum number of plumbing fixtures for each sex shall be determined by the maximum number of persons of that sex which has access to such facilities at any time.

TABLE 4

PLUMBING FIXTURES REQUIRED
FOR NON-INDUSTRIAL ESTABLISHMENTS WHERE PERSONS ARE EMPLOYED
(EXCEPT PLACES OF ASSEMBLY)

Persons of Each Sex	Minimum Number of Water Closets*	Minimum Number of Lavatories
1-15	1	1
16-35	2	2
36-55	3	2
56-80	4	3
81-110	5	3
111-150	6	4
More than 200.	One (1) per 40 additional persons.	

* Note: Where urinals are provided for men and women, one (1) water closet less than the number specified may be provided for each urinal installed, except that the number of water closets in such a case shall not be reduced to less than two-thirds (2/3) of the minimum specified.

(f) Location of Facilities. In every establishment where only one (1) person is employed or works, one (1) water closet and one (1) lavatory for use of its tenant shall be provided within a reasonable distance, not to exceed three hundred (300) feet. In all other establishments, toilet facilities shall be located within the premises and shall not be accessible from an adjoining establishment.

(g) Minimum Facilities for Accredited Bathing Beaches. The number of plumbing fixtures required for each sex at an accredited bathing beach shall be in compliance with Table 5 in 248 CMR 2.10.

TABLE 4A
PLUMBING FIXTURES REQUIRED INDUSTRIAL ESTABLISHMENTS

Persons of Each Sex	Minimum Number of Water Closets	Persons of Each Sex	Minimum Number of Lavatories
1- 10	1	1- 15	1
11- 25	2	16- 35	2
26- 50	3	36- 60	3
51- 75	4	61- 90	4
76-100	5	91-125	5
101-150	7		
151-200	8		
More than 200	one (1) per 25 additional persons	More than 125	one (1) per additional persons

*Note - Where urinals are provided, one water closet less than the number specified may be provided for each urinal installed, except that the number of water closets in such a case shall not be reduced less than two-thirds (2/3) of the minimum specified.

NON-TEXT PAGE

2.10: continued

**In a multiple use lavatory, 24 lineal inches of wash sink or 20 inches of a circular basin, when provided with water outlets for each space, shall be considered equivalent for one (1) lavatory.

TABLE 5

Minimum Number of Plumbing Fixtures Required at Accredited Bathing Beaches

No. of Persons	Water Closets Male	Water Closets Female	Urinals	Lavatories Male	Lavatories Female	Showers (optional) Male	Showers (optional) Female
Less than 1000	2	2	May be substituted for 1/3 of the water closets for each sex	2	2	1	1
Over 1000	Add 1 for every 1000 persons in excess of 1000			Add 1 for every 1000 persons in excess of 1000		Add 1 for every 1000 persons in excess of 1000	

(h) Facilities for the Physically Handicapped Person.

1. Authority. Plumbing fixtures for the physically handicapped shall be installed in conformance with the most recent rules adopted by the Architectural Barrier Board.

2. Scope. The provisions of these rules and regulations are designed to facilitate the use of certain buildings * for the physically handicapped.

(i) Toilet Rooms for Public Use. Toilet rooms accessible to the for public which have two (2) or more water closets or urinals or two (2) or more thereof in combination, shall have a floor drain and a valved hose bibb connection equipped with an approved backflow preventer, for the purpose of flushing and/or sanitary hosing. Said floor drain shall be of an approved design, shall be installed in the vicinity of the urinal(s) and at a grade to permit floor drainage to it from all directions.

(j) Deluge Showers. Deluge showers shall be installed in every school chemistry laboratory classroom or any room used for similar purposes wherein flammable liquids and open flame devices are used in conformance with the most recent regulations adopted by the Board of Fire Prevention.

2.11: Hangers and Supports

(1) General. Piping shall be installed with provisions, when necessary, for expansion, contraction or structural settlement.

(2) Material. Hangers, anchors, and supports shall be of metal or other material of sufficient strength to support the piping and its contents except that piers may be of concrete, brick, or other approved material.

(3) Attachment to Building. Hangers and anchors shall be securely attached to the building at sufficiently close intervals to support the piping and its contents.

(4) Intervals of Supports.

(a) Vertical Piping. Vertical pipe of the following materials shall be supported at not more than the distance intervals shown:

1. Cast iron soil pipe -- at base and at each story height.
2. Threaded pipe (SPS) -- every other story height.
3. Copper tubing -- at each story height but not more than 10-foot intervals.
4. Plastic (PVC and ABS) pipe at each story height, but not more than 10 foot intervals and elsewhere as required to maintain proper alignment.
5. Plastic Polybutylene (PB) tubing at 5 foot intervals, the

2.11: continued

tubing is to be secured with plastic hangers.
6. Stainless steel tubing at each story height but not more than 10 foot intervals.

(b) Horizontal Piping. Horizontal pipe of the following materials shall be supported at not more than the distance intervals shown.
1. Cast iron soil pipe -- 5 foot intervals except that where 10-foot lengths of cast iron soil pipe are used, 10-foot intervals between supports are acceptable.
2. Threaded pipe -- 12-foot intervals.
3. Copper tubing (1 1/4 inch or less) -- 6-foot intervals.
4. Copper tubing (1 1/2 inch or over) -- 10-foot intervals.
5. Plastic (PVC and ABS) pipe (1 1/2" or less) -- 3-foot intervals, (2" or over) --- 4-foot intervals, (Refer to 248 CMR 2.06(2)(n)7.).
6. Plastic Polybutylene (PB) tubing the maximum hanger spacing to be 32 inch intervals for all sizes, tubing is not to be secured rigidly to studs or joists is to be secured with smooth plastic hangers which permit ease of movement during expansion and contraction cycles. (Expansion is approximately 1 in/10 DEG.F/100FT.)
6. Stainless steel tubing at each story height but not more than 10 foot intervals.
7. Stainless Steel Tubing (1 1/4" or less) -- 6-foot intervals.
8. Stainless Steel Tubing (1 1/2" or over) -- 10-foot intervals.

(5) Base of Stacks. Bases of cast iron stacks shall be supported on concrete, brick laid in cement mortar, metal brackets attached to the building, or by other methods approved by the Inspector of Plumbing. Other piping material shall be so anchored as to take the load off the stack at the base.

(6) Piping in Masonry. Piping which is installed in and parallel to the faces of reinforced concrete or masonry walls shall be installed in adequately sized pipe spaces contained in the concrete or masonry walls. Said pipe spaces shall be accessible, or it shall be otherwise installed free of the reinforced concrete or masonry.

2.12: Indirect Waste Piping

(1) Indirect Wastes Required.

(a) Food Handling Establishments. In the case of food handling establishments engaged in the storage, preparation, selling, serving, processing, or otherwise handling food, indirect waste piping shall be provided for refrigerators, refrigerator coils, walk-in freezers, ice boxes, ice making machines, steam kettles, steam tables, potato peelers, egg boilers, coffee urns, and similar types of enclosed equipment. Dishwashing sink and open culinary sinks are excluded from this requirement. The indirect waste shall discharge through an air gap or air break into a trapped and vented receptor except that an air gap is required where the indirect waste pipe may be under vacuum (less than atmospheric pressure).

(b) Connections from Water Distributions System. Indirect waste connections shall be provided for drains, overflows, or relief lines from the water distribution system by means of an air gap.

(c) Sterilizers. Appliances, devices, or apparatus such as stills, sterilizers and similar equipment requiring waste connections and used for sterile materials shall be indirectly connected by means of an air gap.

(d) Drips or Drainage Outlets. Appliances, devices or apparatus not regularly classed as plumbing fixtures but which have drips or drainage outlets, may be drained by indirect waste pipes discharging into an open receptacle through either an air gap or air break.

2.12: continued

(e) Clear Water Wastes. Water lifts, expansion tanks, cooling jackets, sprinkler systems, drip or overflow pans, or similar devices which waste clear water only, when emptying into the building drainage system, shall discharge through an indirect waste by means of an air gap.

(f) Swimming Pools. Pipes carrying waste water from swimming or wading pools including pool drainage, back wash from filters, water from scum gutter drains or floor drains which serve walks around pools, shall be installed as an indirect waste. Circulation pumps may be utilized to lift waste water when the indirect waste line is below the sewer grade. The indirect waste shall discharge into the drainage system through an air gap.

(g) Pressure Tanks, Boilers and Relief Valves. The drains from pressure tanks, boilers, relief valves and similar equipment when connected to the drainage system shall discharge through an indirect waste by means of an air gap.

(2) Air Gap or Air Break Required. All indirect waste piping shall discharge into the building drainage system through an air gap or air break, as set forth in 248 CMR 2.12(1) of this Code and in no instance shall the indirect waste be trapped ahead of the air gap or air break.

(a) Methods of Providing an Air Gap. The air gap between the indirect waste and the building drainage system shall be at least twice the effective diameter of the drain served and shall be provided by one of the following methods:

1. To a Receptor: Extend the indirect waste pipe to an open, accessible individual waste sink, floor drain, or other suitable fixture which is properly trapped and vented. The indirect waste shall terminate a sufficient distance above the flood level rim of the receiving fixture to provide the required air gap, and shall be installed in accordance with this Code.

2. To the Inlet Side of Trap: Provide an air gap in the drain connection on the inlet side of the trap which receives the waste from the indirect waste.

(b) Methods of Providing an Air Break. When an air break is required between the indirect waste and the building drainage system, the distance to which the outlet of the indirect waste pipe extends below the flood level rim of the receptacle into which it is discharging shall be prescribed in this Code.

(3) Receptors or Sumps.

(a) Installation. Waste receptors or sumps serving indirect waste pipes shall not be installed in any toilet room, nor in any inaccessible or unventilated space such as a closet or storeroom.

(b) Cleanout Location. If the indirect waste receptor is set below floor level, it shall be equipped with a running trap adjacent thereto with the trap cleanout brought level with the floor.

(c) Strainers and Baskets. Every indirect waste receptor shall be equipped with a readily removable metal basket over which all indirect waste pipes shall discharge, or the indirect waste receptor outlet shall be equipped with a beehive strainer not less than 4 inches in height.

(d) Splashing to Be Prevented. All plumbing receptors receiving the discharge of the indirect waste pipes, shall be of such shape and capacity as to prevent splashing or flooding.

(e) Domestic or Culinary Fixture Prohibited as Receptors. No plumbing fixture which is used for domestic or culinary purposes shall be used to receive the discharge of an indirect waste except that in a residence a kitchen sink is acceptable for use as a receptor for dishwashers and similarly a laundry tray as a receptor for a clothes washing machine.

2.12: continued

(f) The Stand Pipe Receptors. The stand pipe receptor for an automatic clothes washer shall be installed in one of the following ways:

1. The stand pipe receptor shall be individually trapped and vented provided that the stand pipe extends no more than 30 inches nor less than 18 inches above its trap and in no case shall the trap be installed below the floor.

2. The stand pipe receptor shall be installed in the cover of a floor drain provided the cover is tapped to receive the stand pipe. The size of the floor drain shall depend on the discharge rate of the automatic clothes washer or the floor area to be drained, whichever is greater.

(4) Condenser Sumps. No steam pipe shall connect to any part of a drainage or plumbing system, nor shall any water above 150°F. be discharged into any part of a drainage system. Such pipes shall be connected by discharging into an indirect waste receptor connected to the drainage system.

(5) Installation of Indirect Waste Piping.

(a) Accessibility. Indirect waste piping shall be installed so as to permit ready access for flushing, cleaning, or replacement.

(b) Material, Slope, Sizing, and Approval.

1. The piping material to be used, its size and the slope at which it is installed shall meet the requirements of this Code.

2. Any fixture or piece of equipment to be indirectly wasted that has a waste outlet smaller than 1 1/4 inches in diameter shall be connected to an indirect waste pipe on size larger than said outlet.

(c) Indirect Waste Piping Described.

1. Individual Indirect Waste. An indirect waste which connects to one waste outlet and extends to the receiver shall be classified as an Individual Indirect Waste.

2. Indirect Waste Main. An indirect waste which connects to more than one waste outlet and extends to the receiver shall be classified as an Indirect Waste Main.

3. Indirect Waste Branch Main. A branch from an indirect waste main which connects to more than one waste outlet shall be classified as an Indirect Waste Branch Main.

4. Indirect Waste Branch. An indirect waste which connects to one waste outlet and extends to either an indirect waste main or an indirect waste branch main shall be classified as an Indirect Waste Branch.

(d) Traps.

1. Where Not Permitted. A trap shall not be installed on an indirect waste main or on an indirect waste branch main.

2. Where Permitted. On any indirect waste branch or individual indirect waste where it is necessary or desirable to prevent the flow of air from inside the indirect waste piping thorugh the indirect waste branch.

(e) Air Circulation Through Indirect Waste Piping.

1. Provision shall be made so that air can circulate freely through an individual indirect waste, and indirect waste main or an indirect waste branch main.

2. Only an indirect waste branch may be trapped and when the trapping of indirect waste branch or branches will interfere with the free flow of air through the indirect waste main or branch main, additional ventilation outlets shall be provided to permit the free flow of air.

3. An indirect waste stack receiving the discharge from fixtures on two or more floors shall be extended to the outer air as required for a stack vent.

2.12: continued

(6) Multiple Occupancy.

(a) When a system of indirect waste piping serves buildings or premises having more than one tenant occupancy, it shall be designated as a "Central Indirect Waste System" and connection to it from separate tenant occupancies shall be designated as "Separate Indirect Waste Systems."

(b) Separate indirect waste systems shall be connected to "Central Indirect Waste Systems" as follows:

1. The indirect waste branch to a separate occupancy shall be trapped, and this trap shall serve as a secondary indirect waste receiver for the separate indirect waste system.

2. The indirect waste branch to a separate occupancy may be from a horizontal indirect waste main or branch main, or from an indirect waste stack.

(c) Secondary Indirect Waste Receivers

1. Traps serving secondary indirect waste receivers shall be protected from siphonage by adequate individual battery of stack vents.

2. Vents on indirect waste piping systems shall not be connected to the vents of any other piping system but shall be extended separately to the outer air as required for stack vents.

2.13: Piping and Treatment of Special Wastes.

(1) General.

(a) 248 CMR 2.13 governs the methods and materials, testing and inspection of waste systems other than from standard plumbing fixtures.

(b) All plans and specifications for special waste piping and treatment systems shall be prepared by a registered professional engineer and shall be submitted to the local plumbing inspector or the authority having jurisdiction. However, only a registered professional engineer shall design systems handling biological, biogenetic, genetic, DNA, radioactive, nuclear, solvents, or perchloric wastes. When required the plans, specifications, and other pertinent data, as requested, shall be submitted by the designer to the Department of Environmental Quality Engineering (DEQE) or other authorities for their review and approval.

(c) Permits shall be applied for on the basis of plans approved under 248 CMR 2.13(1)(b) and inspections shall be conducted for the work described in 248 CMR 2.13 in accordance with the requirements noted in this section. In addition, applications for permits and inspections shall also be subject to the provisions of 248 CMR 2.04 to insure compliance with all the requirements of this Code and to assure that the installation and construction of the plumbing system is in accordance with approved plans.

(d) All special wastes shall be conveyed in separate piping systems.

(e) 248 CMR 2.13 shall include, but shall not be limited to, all special wastes such as biological, chemical, nuclear, radioactive, deionized, acids, perchloric, solvents and alkalines from laboratories and industrial activities.

(f) Nuclear or radioactive waste treatment and/or disposal shall conform to the standards of the Nuclear Regulatory Commission, N.R.C.

(g) Color Marking - Lines conveying special wastes shall be painted yellow. This requirement may be met by painting three inch (3") wide bands at intervals of not more than twenty-five feet (25') and at points where piping passes through walls, floors and roofs, in which case the bands shall be applied to the piping on both sides of the walls and both above and below the floor or roof. Snap-on bands marked "special wastes" may be used and spaced as described herein for painted bands. Points of outlet for special wastes shall also be color-coded yellow.

2.13: continued

(2) Approved Materials: Fixtures and Piping Systems. List of Fixture Materials.

(a) High silicon (14.5% silicon cast iron)
(b) Polypropylene
(c) Polyethylene
(d) Glass
(e) Chemical stoneware
(f) Lead
(g) Stainless Steel Type #316 - 18-8
(h) Chemical resistant monolith epoxy resins.

All materials listed below shall be installed and joined in accordance with the manufacturer's recommendation and 248 CMR 2.11. Pipes shall be furnished in straight lengths and each length shall be marked with the manufacturer's name and the type of material. For applicable material standard, refer to 248 CMR 2.06.

Pipe and Fittings

Materials	Joining Methods	Above Ground	Below Ground
High Silicon cast iron	Acid Resistant packing with caulked lead joint or Mechanical Clamp	Yes	Yes
Glass Pipe	Mechanical Clamp	Yes	Yes (1) (3)
Polypropylene Sch. 40 or 80	Heat Fusion	Yes (2) (5)	Yes (5)
Polypropylene Sch. 40 or 80	Mechanical Joints Clamp or Flange	Yes (2) (4) (5)	Yes (3) (5)
Polyethylene	Heat Fusion	Yes (2) (5)	Yes (5)

1. Buried glass pipe shall be sleeved with rigid foam casing.
2. Shall be flame retardent above ground.
3. Only stainless steel mechanical joint clamps or heat fusion joining method shall be used underground.
4. Flanges may be used above ground with proper gasketing material for corrosive resistance to the waste carried and compatability with the piping material.
5. I.P.S. threaded joints may be used on schedule 80 polypropylene, polyethylene.

(3) Vents Serving Corrosive Wastes. Vent pipes shall not be connected to vents of the sanitary system but shall be extended through the roof with acid resistant pipe.

(4) The Design and Installation of New Special Waste Systems Including Additions, Renovations, Alterations or Revisions To Existing Systems. The owner shall submit a notarized letter stating the materials to be disposed of, or discharged into the special waste system. This letter shall be attached to the plans submitted per the requirements in 248 CMR 2.13(1), and will be the basis of the engineer's design.

(a) The special waste system receiving the discharge of corrosive liquids regardless of the size or number of fixtures, shall be installed separately from the other parts of the building plumbing system. The waste shall terminate at a point ten feet (10') beyond the outlet of the final treatment or the inner face of the exterior foundation wall and shall be a minimum size of four inches. (4").

(b) That portion of piping from the outlet of the neutralizing and treatment device to a point ten feet (10') beyond the inner face of

2.13: continued

the foundation wall shall be of a material approved for special waste systems.

(c) Pumped discharge from a special waste system shall be constructed of pressure rated pipe and fittings, and be of material compatible with and approved for special waste systems.

(d) Pump wetted parts, pit lining, pit frames, and pit covers shall be constructed of materials chemically resistant to the liquids being collected and pumped.

(e) Alternate design of a system, materials and/or termination points shall be considered only where evidence is presented that the standard contained in 248 CMR 2.13(4)(a) through (d) cannot reasonably be complied with. The plan for an alternative system shall be submitted to the local plumbing inspector or authority having jurisdiction for review and approval.

(5) Plumbing Layouts for Laboratory Sinks and Tables.

(a) General. The installation of waste and venting system for piping handling corrosive liquids shall be the same as sanitary waste and vent piping, except as modified in 248 CMR 2.13.

(b) Traps. A trap serving a hood or similar type piece of enclosed equipment may not be used to serve another fixture outside the hood enclosure and more than one hood may not be served by the same trap.

(c) Individual Venting of Traps.

1. Individual vents shall be provided whenever a battery waste and vent system is not being used.

2. When more than one fixture is served by a single continuous waste and vent, the branch fittings to receive the discharge from traps need not be at the same elevation.

(d) Battery Systems of Waste and Vent Piping.

1. The main horizontal branch drain shall be one pipe size larger than that required by the fixture units connected to it. (Figure cup sinks as one fixture unit.) Horizontal piping size three inches (3") and smaller shall have a minimum slops of one-quarter inch (¼") per foot.

2. In battery venting, the vent shall be connected to the drain between the last and second last branches to fixture traps and a relief vent shall be connected to the main drain between the waste stack and the first branch to fixture trap on all but the highest connection to a stack.

3. Additional relief vents are required on battery systems of waste and vent piping when the total number of traps served on any one main drain or branch main drain exceeds six (6), and each additional relief vent may serve from one (1) to five (5) additional traps. Minimum size of relief vents shall be two inches (2"). Any branch from a main batteey waste which has a separate trap vent may be considered as a relief vent and every branch waste having a developed length exceeding ten feet (10') shall be individually vented.

4. The vent for a main battery waste shall be at least one-half the diameter of the horizontal branch drain.

5. Floor drains may be connected to the horizontal main battery drain with traps below the floor; the minimum size of the branch shall be not less than three inches (3") and the main branch to which the floor drain waste is connected need not be larger than the branch to the floor drain, a separate trap vent is not required unless the developed length from centerline of floor drain trap inlet exceeds fifteen feet (15'). Floor drain traps shall be included in determing relief vent requirements.

6. Whenever the main horizontal branch of battery waste piping is below the floor on which the fixtures occur, either a drum trap or a P trap may be used and a cleanout shall be installed in the vertical waste above the floor. See 248 CMR 2.23, Figure #11.

2.13: continued

(6) Sizing for Neutralizing Sumps

(a) The normal laboratory sink will produce on the average about ten (10) gallons per hour of affluent and this is the basis which should be used to size the neutralizing sump.

The smallest size sump to be used should have a capacity of five (5) gallons which will handle a single laboratory sink or a cup sink. To size a sump for more than one (1) sink, the following Table 1 should be used.

TABLE 1

Maximum Number Of Sinks Handled	Tank Capacity In Gallons	Minimum Inlet Outlet and Vent Sizes
1	5	2
4	15*	2
8	30	3
16	55	4
25	100**	4
40	150	4
60	200	4
75	250	4
100	350	4
150	500	4

(b) The use of materials other than those specified and wastes requiring special treatment before entry into the normal plumbing system, must be approved by the Board of State Examiners of Plumbers and Gasfitters.

(c) The neutralizing materials to be used should be either:

1. For dilute acid waste water. Limestone in pieces of one to three inches (1"-3") diameter size range must contain a high calcium carbonate content in excess of ninety percent (90%). If the neutralizing medium selected islimestone, then its fill level must be from the sump tank bottom to the invert of the inlet pipe.

2. For acidic and alkaline waste. Caustic Soda (NaOH) and Sulfuric Acid (H_2SO_4) or other neutralizing agents may be added through metering pumps to control the pH.

(d) Maintenance of Neutralizing Sumps. In order to insure the correct operation of this system it shall be inspected monthly (by removing the cover, checking the level of limestone chips and adding chips if necessary) and neutralizing materials be replaced or replenished as required.

A sign shall be stencilled on or in the immediate area of the sump in letters one inch (1") high. This sign shall read:

"IMPORTANT"

"This sump must be inspected on a regular and frequent basis and the neutralizing medium or agent replaced when necessary. Failure to do so will result in serious damage to the piping system."

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*Sumps 15 gallons and larger shall be chamber vented.

**When in the judgement of the professional engineer, a neutralizing tank is to be equipped with a pH system, the pH system should be equipped with an audio-visual alarm. The regulatory agency may also require an "outflow" recorder for pH. The alarm and recorder shall function when the system is operating.

2.13: continued

(e) Materials of Sumps.
1. High-Density Polyethylene*
2. Chemical Stoneware
3. Polypropylene
4. Fiber Glass Reinforced Plastic (FRP)*
5. Precast or poured in place concrete chambers with a liner resistant to the special waste being discharged.
6. The use of materials other than those specified above must be approved by the Board of State Examiners of Plumbers and Gasfitters.

(f) Curbing Around Sumps. DEQE standards require curbing around sumps above certain sizes.

(7) Discharge of Waste Through Troughs.

(a) Laboratory furniture and casework which utilize troughs for the discharge of wastes shall be independently trapped, wasted or vented unless the waste outlet is within thirty inches (30") of a properly wasted and vented sink.

(b) Where troughs or floor trenches are required to intercept floor spills, or are required for tank or equipment drainage, the outlets from the trough or trenches shall be equipped with acid resisting grating and lining and the system shall be trapped and vented as hereinbefore specified.

(8) pH Adjustment Tanks.

(a) Where it is inadvisable or impractical to install a neutralizing sump with either marble or limestone chips to bring pH factor of waste materials up to neutral zone or where the pH factor of anticipated wastes may vary from acid range through neutral zone and up into the alkaline range a pH adjustment tank is to be provided.

(b) pH adjustment tanks may be installed for partial or entire building systems.

(c) pH adjustment tanks will consist of an acid/alkaline resisting tank, receiving wastewater from one (1) or more sinks. This tankis to be sized according to Table 1 above. The tankis to have an agitator, which will run when serving sinks/cupsinks, etc. are in use. Tank will also have a sensor, todetect the pH of tank contents, within a range of2 (acid) to 12 (alkaline). This sensor is tobe electrically connected to a control panel. This control panel is to be connected to acid/alkaline pumps. Acid/alkaline pumps are to beinserted into tanks containing neutralizing agents to bring tank contents up from an acid pH ordown from an alkaline pH to a range of 6 to 9. The discharge of each pumpis to run directly topH adjustment tank. See schematic sketchin 248 CMR 2.13(8)(a).

(d) When in the judgement of the professional engineer a neutralized tankis to be equipped with a pH system, the pH system shall be equipped with an audio-visual alarm. The regulatory agency may also require an "outflow" recorder for pH. The alarm and recorder shall function atall times the systemis operating.

(9) Genetic or D.N.A. Laboratory Wastes.

(a) Waste piping from genetic laboratories or areas in laboratories where genes of live cells are manipulated, changed or revised are NOT to be run directly to the street sewer regardless of pH factor. All such wastes shall first be sterilized to kill all live cells. Once the cells are dead, the waste may be disposed of into a holding tank. This holding tank is to have a sampling device and a high water alarm. The alarm shall be activated when the tank's contents have reached a predetermined level. The sampling device is to

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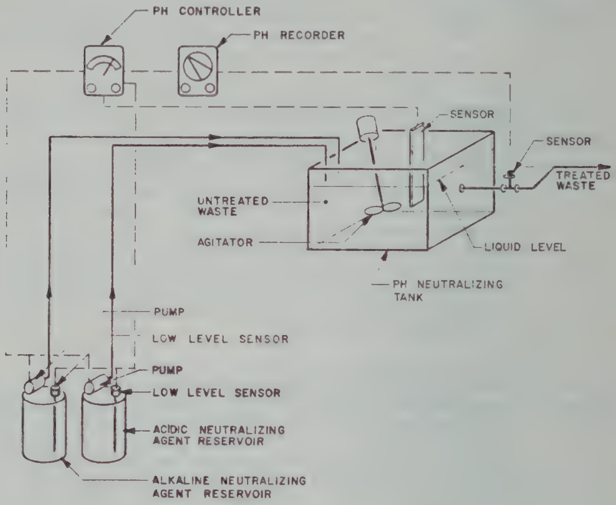
*Sump material subject to distortion by heat or other factors, when in use, must be restrained or enclosed.

2.13: continued

consist of a pump to transfer a selected sample into the control area of the laboratory for verification that it contains no living organisms. When the sample contains no living organism, the contents of the tank can then be allowed to enter the sewer system.



(b) If live cells are discovered by the sampling process, the contents of the fermentation tank shall be resterilized and retested before being allowed to enter into the sewer.
(c) The fermentation tank must be sterilized before it is returned to service.
(d) In laboratories where there are both fermentation and purification areas, each is to be run to its own separate holding tank. Solvent bearing waste from purification tanks shall be disposed of according to applicable DEQE regulations.

(10) Industrial Wastewater. When useage of either a neutralizing sump or a pH adjustment tank would be inadequate to treat the industrial waste water discharge and therefore, not comply with applicable regulatory limits on special waste, an industrial wastewater treatment system shall be designed by an engineer and plans and specifications shall be submitted to the Department of Environmental Quality Engineering (DEQE) or other authorities are as required.

2.14: Water Supply and Distribution

(1) Potable Water Supply.
(a) Buildings. Every building equipped with plumbing fixtures and used for human occupancy or habitation shall be provided with a potable supply of cold water in the amounts and at the pressures specified in 248 CMR 2.14. For permanent residences or buildings in which people are employed, hot water shall be provided.
(b) Use of Non-Potable Water Prohibited. Only potable water shall be accessible to plumbing fixtures supplying water for drinking, bathing, culinary use or the processing of food, medical or pharmaceutical products.

2.14: continued

(2) Water Service. The water service pipe shall be of sufficient size to furnish water to the building in the quantities and at the pressure required elsewhere in this Code. It shall, in no case, be less than 3/4 inch nominal diameter. Methods for sizing the water service pipe shall be the same as required in 248 CMR 2.14(3), Designing and Sizing the Building Water Distribution System.

(3) Designing and Sizing the Building Water Distribution System.

(a) Methods to Be Used. The design of the building hot and cold water distribution system shall conform to good engineering practice and methods. Methods used to determine pipe sizes shall be the procedure as set forth in Appendix "D" of the United States Public Health Service publication #1038, or a system designed by a registered professional engineer, or computation using TABLES 1,2, and 3, in 248 CMR 2.14. (An example of the use of these tables is shown following TABLE 3 in 248 CMR 2.14).

1. The minimum size of a fixture supply pipe shall be in accordance with TABLE 1 in 248 CMR 2.14.

2. From the size and number of fixture supply lines, the building service, main and distribution piping may be determined from TABLES 1, 2, and 3 in 248 CMR 2.14.

3. In order to size the hot and/or cold water main for a building, they must be computed on an individual basis.

TABLE 1

MINIMUM SIZES OF FIXTURE WATER SUPPLY LINES
AND FACTOR VALUES

TYPE OF FIXTURE OR DEVICE	Nominal Pipe Size (inches)	Factor Value
Bathtubs	1/2	2
Combination sink and tray	1/2	2
Drinking fountain	3/8	1
Dishwasher (Domestic)	1/2	2
Kitchen sink, residential	1/2	2
Kitchen sink, commercial	3/4	6
Lavatory	3/8	1
Laundry tray, 1, 2, or 3 compartments[1]	1/2	2
Shower (single head)	1/2	2
Sinks (service, slop)	1/2	2
Sinks flushing rim	3/4	6
Urinal (flush tank)	1/2	2
Urinal (direct flush valve)	3/4	6
Water closet (tank type)	3/8	1
Water closet (flush valve type)	1	12
Hose bibbs	1/2	2
Wall hydrant	1/2	2

Note 1: If washing machine connections are used in place of laundry tray, use laundry tray pipe sizes in determining capacity values.

2.14: continued

TABLE 2

Occupancy Use	Demand Factors
RESIDENTIAL	
One (1) or two (2) family dwelling	0.50
Multi-Residential	0.35
Hotel	0.70
SCHOOL	
General	0.75
Shower Room	1.00
INSTITUTIONAL	
General	0.45
ASSEMBLY	
General	0.25
Restaurant, cafe	0.70
Club House	0.60
BUSINESS AND MERCANTILE	
General	0.25
Laundry	1.00
INDUSTRIAL	
General, exclusive of process piping	0.90

A demand factor (Table 2 in 248 CMR 2.14) may be applied to determine the minimum pipe size for building service, main and distribution system piping.

TABLE 3

CAPACITY VALUES FOR SERVICE, MAINS, RISERS AND/OR BRANCHES

Nominal Pipe or Tubing Sizes (inches)	Capacity Value
3/8	1
1/2	1.1 to 4
3/4	4.1 to 9
1	9.1 to 16.5
1 1/4	16.6 to 28
1 1/2	28.1 to 55
2	55.1 to 107.5
2 1/2	107.6 to 182.5
3	182.6 to 287.5
3 1/2	287.6 to 425
4	425.1 to 700
5	700.1 to 1100
6	1100.1 to 1300

TABLE 3A

POLYBUTYLENE (PB) TUBING
CAPACITY VALUES FOR MAINS, RISERS AND/OR BRANCHES

Normal Tubing Sizes (inches)	Capacity Value
3/8	.75
1/2	.76 to 3
3/4	3.1 to 6.8
1	6.9 to 12.4
1 1/4	12.5 to 21
1 1/2	21.1 to 41.4
2	41.4 to 80.6

2.14: continued

EXAMPLE:
Use of Tables 1, 2 and 3 in 248 CMR 2.14 to determine size of the cold water main for a one family residence having the following fixtures:

A.......................	2 Water closets (Tank type)
B.......................	2 Lavatories
C.......................	1 Bathtub
D.......................	1 Shower Stall
E.......................	1 Laundry Tray
F.......................	1 Dishwasher (Domestic)
G.......................	1 Kitchen Sink
H.......................	2 Wall Hydrants

FACTOR VALUES (From Table 1 in 248 CMR 2.14)

			HOT		COLD		
A	(2)	Water Closets (tank type) X 1		=	2		
B	(2)	Lavatories X 1	2		2		
C	(1)	Bathtub	2		2		
D	(1)	Shower Stall	2		2		
E	(1)	Laundry Tray	2		2		
F	(1)	Dishwasher (Domestic)	2				
G	(1)	Kitchen Sink	2		2		
H	(1)	Wall Hydrant			4		
		TOTAL	12		16	=	28

Table 14.3.1.b. indicates a Demand Factor of 0.50 for a one (1) or two (2) family dwelling.

Multiplying the total Factor Value of 28 by the Demand Factor of 0.50 results in a Capacity Factor of 14.0
A Capacity Factor of 14 lies between 9.1 and 16.5 in Table 14.3.1.c and related pipe size is 1.

(b) Size of Fixture Supply. The minimum sizes of a fixture supply pipe shall be as shown in Table 1 in 248 CMR 2.14 -- Minimum Sizes of Fixture Supply Pipes. The fixture supply pipe shall be extended to within at least 30 inches of the point of connection to the fixture.

(c) Water Hammer. All building water supply systems in which quick acting valves are installed shall be provided with devices to absorb high pressures resulting from the quick closing of these valves. These pressure absorbing devices shall be either air chambers, provided with a means for restoring the air should the chambers become waterlogged or approved mechanical devices. Water pressure absorbers shall be placed as close as possible to the quick acting valves and shall be accessible for maintenance or replacement.

1. Air Chambers: Standard air chambers may be installed at the ends of long pipe runs or near batteries of fixtures.
2. Mechanical Devices: Where mechanical devices are used, the manufacturer's specifications shall be followed as to location and method of installation.

(d) Inadequate Water Pressure. Whenever water pressure from the street main or other source of supply is insufficient to provide flow pressures at fixture outlets as required under 2.48 CMR 2.14(3)(g), a booster pump and pressure tank or other approved means shall be installed on the building water supply system.

(e) Variable Street Pressures. Where street main pressures fluctuate, the building water distribution system shall be designed for the minimum pressure available.

(f) Supply Demand. The supply demand in gallons per minute in the building water distributing system shall be determined on the

2.14: continued

basis of the load in terms of supply fixture units and of the relationship between load and supply demand.

(g) Minimum Pressures Required in Water Distribution System. Based on the minimum static water pressure available, pipe sizes shall be selected so that under conditions of peak demand a minimum flow pressure at the point of discharge shall not be less than shown in Table 4 in 248 CMR 2.14 -- Minimum Flow Pressure and Flow Rates. In determining minimum pressures at the outlets, allowance shall be made for the pressure drop due to friction loss.

TABLE 4
MINIMUM FLOW PRESSURE AND
FLOW RATES

LOCATION	FLOW PRESSURE p.s.i.	FLOW RATE, g.p.m.
Ordinary basin faucet	8	2.0
Self-closing basin faucet	8	2.5
Sink faucet, 3/8 inch	8	4.5
Sink faucet, 1/2 inch	8	4.5
Bathtub faucet	8	6.0
Laundry tub cock, 1/2 inch	8	5.0
Shower	8	5.0
Ball-cock for closet	8	3.0
Flush valve for closet	15-20	15.35
Flushometer valve for urinal	15	15.0
Drinking fountains	15	0.75
Sill cock-wall hydrant	10	5.0

Note 1: Wide range due to variation in design and type of closet.

(h) Excessive Water Pressure. When street main exceeds 80 p.s.i., an approved pressure reducing valve shall be installed in the water service pipe near its entrance to the building to reduce the water pressure to 80 p.s.i. or lower, except where the water service pipe supplies water directly to a water pressure booster system, an elevated water gravity tank, or to pumps provided in connection with a hydropneumatic or elevated gravity water supply tank system. Pressure at any fixture shall be limited to no more than 80 p.s.i. under no-flow conditions.

Systems designed by a registered professional engineer shall be accepted and said engineer shall be responsible for the safety and performance of such designed system.

(4) Installing The Building Water Distribution System.

(a) Meter Valve. A gate valve or other full-way valve shall be installed in the line on the discharge side of each water meter. The valve shall not be less in size than the building water service.

(b) Riser Valves. Except in single family dwellings, a valve shall be installed at the foot of each water supply riser. In multistory buildings, a valve shall be installed at the top of each water supply downfeed pipe from a booster system.

(c) Valves in Dwelling Units. If individual fixtures valves are not installed in two-family or multiple family dwelling units, one or more control valves shall be provided so that the water to any unit may be shut off without stopping flow of water to other units. These valves shall be readily accessible inside the unit controlled.

(d) Individual Fixture Valves. In occupied buildings other than dwellings, the water service line to each fixture or other piece of

2.14: continued

equipment shall be provided with a valve or fixture stop to shut off the water to the fixture or to the room in which it is located. All sill cocks and wall hydrants shall be separately controlled by a valve inside the building.

(e) Tank Controls. Supply lines from pressure or gravity tanks shall be valved at or near the tanks.

(f) Water Heating Equipment Valve. The cold water branch to each hot water storage tank or water heater shall be provided with a valve located near the equipment and above the top of the tank.

(g) Valves to Be Accessible. All water supply control valves shall be placed so as to be accessible for service and maintenance. All concealed tub or shower valves shall be provided with renewable seats.

(h) Control Valve Design. Except to single fixtures, control valves on all water lines, shall, when fully opened, have a cross sectional area not less than the cross sectional area of the line in which they are installed.

(i) Draining Systems. Drain cocks or valves shall be provided at all low points so that every portion of the water piping system can be drained.

(5) Water-Pressure Booster Systems.

(a) Water Pressure Booster Systems Required. When water pressure in the public water main or individual water supply system is insufficient to supply the probable peak demand flow to all plumbing fixtures and other water needs freely and continuously with the minimum pressures and quantities, specified in or elsewhere in this Code and in accordance with good practice, the rate of supply shall be supplemented by:

1. A gravity water tank.
2. A hydro-pneumatic pressure booster system.
3. A tankles pressure booster installed in accordance with 248 CMR 2.14(5)(e).

(b) Support. All water supply tanks shall be supported in accordance with the building code or other regulations which apply.

(c) Covers. All water supply tanks shall be covered to keep out unauthorized persons, dirt, and vermin. The covers of gravity tanks shall be vented with a return bend vent pipe having an area not less than the area of the down feed riser pipe and the vent shall be screened with corrosion resistant screen of not less than 16 x 20 mesh.

(d) Overflows for Water Supply Tanks. Each gravity or suction water supply tank shall be provided with an overflow having a diameter not less than shown in Table 5 in 248 CMR 2.14 -- "Sizes of Overflow Pipes for Water Supply Tanks." The overflow outlet shall discharge above and within not less than six (6) inches of a roof or roof drain, floor or floor drain or over an open water supplied fixture. The overflow outlet shall be covered by a corrosion resistant screen of not less than 16 x 20 mesh to the inch and by ¼ inch hardware cloth or shall terminate in a horizontal angle seat check valve. Drainage from overflow pipes shall be directed so as not to freeze on roof walkways.

2.14: continued

TABLE 5

SIZES OF OVERFLOW PIPES FOR WATER SUPPLY TANKS

Maximum Capacity of Water Supply Line to Tank	Diameter of Overflow Pipe (inches ID)
0-50 gpm	2
51-100 gpm	2 ½
101-165 gpm	3
166-355 gpm	4
356-640 gpm	5
641-1,040 gpm	6
Over 1,040 gpm	8

(e) Low Pressure Cut-Off Required on Booster Pumps. When a booster pump is used on a water pressure booster system and the possibility exists that a positive pressure of 10 psi or less may occur on the suction side of the pump, there shall be installed a low pressure cut-off on the booster pump to prevent the creation of a vacuum or negative pressure on the suction side of the pump, thus cutting off water to other outlets.

(f) Potable Water Inlet Control and Location. Potable water inlets to gravity tanks shall be controlled by a ballcock or other automatic supply valve so installed as to prevent the tank from overflowing. The inlet shall be terminated so as to provide an accepted air gap but in no case less than 4 inches above the overflow.

(g) Tank Drain Pipes. Each tank shall be provided at its lowest point with a valved pipe to permit emptying the tank which shall discharge as required for overflow pipes and not smaller in size than shown in Table 6 in 248 CMR 2.14 -- "Sizes of Drain Pipes for Water Tanks."

TABLE 6

SIZES OF DRAIN PIPES FOR WATER TANKS

TANK CAPACITY (gallons)	DRAIN PIPE (inches)
Up to 750	1
751 to 1,500	1½
1,501 to 3,000	2
3,001 to 5,000	2½
5,001 to 7,500	3
Over 7,500	4

(h) Prohibited Location of Potable Supply Tanks. Potable water gravity tanks or manholes of potable water pressure tanks shall not be located directly under any soil or waste piping.

(i) Pressure Tanks -- Vacuum Relief. All potable water pressure tanks shall be provided with a vacuum relief valve at the top of the tank which will operate up to a maximum water pressure of 200 psi and to a maximum water temperature of 200°F. The minimum size* of such vacuum relief valves shall be 1/2 inch. Valves marked with the A.G.A. symbol and listed by the American Gas Association Laboratories will be considered in compliance with this Section. Valves shall have a minimum 1/2 diameter orifice and the air inlet opening on any vacuum valve shall not be smaller than the nominal pipe size of the valve.

*Note: Vacuum relief valves shall be sized so as to have a cross

2.14: continued

sectional area equal at the valve seat not less than one pipe size smaller than the cold water supply. Vacuum relief valves may be installed in multiples.

(j) Pumps and Other Appliances. Water pumps, filters, softeners, tanks and all other appliances and devices used to handle or treat potable water shall be protected against contamination.

(6) Protection of Potable Water Supply.

(a) General. A potable water supply system shall be designed, installed and maintained in such manner as to prevent contamination from nonpotable liquids, solids, or gases from being introduced into the potable water supply thorugh cross connections or any other piping connections to the system.

(b) Identification of Potable and Nonpotable Water. In all buildings where dual water distribution systems, one potable water and the other nonpotable water, are installed, each system shall be identified either by color or metal tags.

1. Color Marking. When color marking is used, potable water lines shall be painted green and nonpotable water lines shall be painted yellow. This requirement may be met by painting 3 inch wide bands green or yellow at intervals of not more than 25 feet and at points where piping passes through walls, floors or roofs in which case the bands shall be applied to the piping on both sides of the walls and both above and below the floor or roof. Points of outlets for nonpotable water shall be marked with a tag or color coded.

2. Metal Tags. When tags are used, potable water lines shall be identified by 3-inch diameter metal tags bearing the legend SAFE WATER in letters not less than 1/2 inch in height.

Nonpotable water lines shall be identified by firmly attached metal tags having the shape of a 4-inch equilateral triangle bearing the legend WATER UNSAFE in letters not less than 7/16 inches in height.

As in the use of color bands, tags shall be attached to pipes at intervals of not more than 25 feet and at either side of points where pipes pass through walls and above and below points where pipes pass through floors or roofs.

(c) Cross Connection Control. Cross connections between potable water systems and other systems or equipment containing water or other substances of unknown or questionable safety are prohibited except when and where, as approved by the Massachusetts Department of Environmental Quality Engineering, suitable protective devices such as the reduced pressure zone backflow preventer or equal are installed, tested, and maintained to insure proper operation on a continuing basis.

(d) Interconnections.

1. Individual Water Supplies. Cross connections between an individual water supply and a potable public supply shall not be made unless specifically approved by the Massachusetts Department of Environmental Quality Engineering.

2. Public Water Supplies. Interconnection between two or more public water supplies shall be permitted only with the approval of the health authority having jurisdiction.

(e) Toxic Materials.

1. Construction. Piping conveying potable water shall be constructed of nontoxic material.

2. Materials and Substances. No materials or substances that could produce either toxic conditions, taste, odor, or discoloration in a potable water system shall be introduced into or used in such systems.

3. Painting of Water Tanks. The interior surface of a potable water tank shall not be lined, painted, or repaired with any

2.14: continued

material which will affect either the taste, odor, color, or potability of the water supply when the tank is placed in or returned to service.

(f) Used Piping. Piping which has been used for any other purpose than conveying potable water shall not be used for conveying potable water.

(g) Water Connections to Heating Boilers. Potable water connections to a heating boiler shall be provided with an approved back flow preventer or air gap in the water line to prevent a cross connection. Backflow preventers shall not be required on manually controlled water lines to residential type steam and/or gravity fed hot water space heating systems.

(h) Prohibited Connections to Fixtures and Equipment. Connection to the potable water supply system for the following shall be protected against backflow:

1. Bidets,
2. Operating, dissection, embalming, and mortuary tables or similar equipment -- in such installation, the hose used for water supply shall terminate at least 12 inches away from every point of the table or attachments,
3. Pumps for nonpotable water, chemicals or other substances -- priming connections may be made only through an air gap,
4. Building drainage, sewer or vent sytems,
5. Any other fixture of similar hazard.

(i) Refrigerating Unit Condensers and Cooling Jackets. Except where potable water provided for a refrigerator condenser or cooling jacket is entirely outside the piping or tank containing a toxic refrigerant, with two separate thicknesses of metal separating the refrigerant from the potable water supply the inlet connection shall be provided with an approved double check valve installation. Also adjacent to and at the outlet side of the check valve, an approved pressure relief valve set to relieve at 5 psi above the maximum water pressure at the point of installation shall be provided if the refrigeration units contain more than 20 pounds of refrigerants.

(j) Used Water Return Prohibited. Except as provided for below, water used for cooling of equipment or other processes shall not be returned to the potable water system. Such water shall be sidecharged into the drainage system through an air gapped indirect waste. Under conditions where water shortage may occur, the water used for cooling may be used for nonpotable purposes.

(k) Protection Against Backflow and Backsiphonage.

1. Water Outlets. A potable water system shall be protected against backflow and backsiphonage in accordance with Chapter 111, Section 160 A of the General Laws, and the rules and regulations promulgated by the Massachusetts Department of Environmental Quality Engineering relative to protection of the potable water supply.

Air Gap: An air gap as specified herein between the potable water outlet and the flood level rim of the fixture it supplies or between the outlet and any other source of contamination, or

Backflow Preventer: A backflow preventer device or vacuum breaker to prevent the drawing of contamination into potable water system.

2. Minimum Required Air Gap.

How measured: The minimum required air gap shall be measured vertically from the lowest end of a potable water outlet to the flood rim or line of the fixture or receptacle into which it discharges.

Size: The minimum required air gap shall be twice the effective opening of a potable water outlet unless the outlet is a distance less than 3 times the effective opening away from a wall or similar vertical surface in which case the minimum required air gap shall be 3 times the effective opening of the outlet. In no case shall the minimum required air gap be less than shown in Table 7 in 248 CMR 2.14 -- Minimum Air Gaps for Plumbing Fixtures.

2.14: continued

TABLE 7 MINIMUM AIR GAPS FOR PLUMBING FIXTURES	Minimum Air Gap When not affected by near wall[1] (Inches)	Minimum Air Gap When affected by near wall[2] (Inches)
Lavatories and other fixtures with effective openings not greater than 1/2 inch diameter.	1.0	1.50
Sink, laundry trays, goose-neck bath faucets and other fixtures with effective openings not greater than 3/4 inch diameter	1.5	2.25
Over rim bath fillers and other fixtures with effective openings not greater than 1 inch diameter.	2.0	3.0
Drinking water fountains-single orifice 7/16 (0.437) in. diameter or multiple orifices having total area of 0.150 sq. in. (area of circle 7/16 in. diameter)	1.0	1.50
Effective openings greater than 1 inch	2X diameter of effective opening	3X diameter of effective opening

Note 1: Side wall, ribs or similar obstructions do not effect air gaps when spaced from inside edge of spout opening a distance greater than three times the diameter of the effective opening for a single wall, or a distance greater than four times the diameter of the effective opening for two intersecting walls.

Note 2: Vertical wall, ribs, or similar obstructions extending from the water surface to or above the horizontal plane of the spout opening require a greater air gap when spaced closer to the nearest inside edge of spout opening than specified in Note 1, above. The effect of three or more such vertical walls or ribs has not been determined. In such cases, the air gap shall be measured from the top of the wall.

3. Devices for the Protection of the Potable Water Supply. Approved backflow preventers or vacuum breakers shall be installed with any plumbing fixture or equipment, the potable water supply outlet of which may be submerged and which cannot be protected by a minimum air gap.

4. Approval of Devices. Before any device for the prevention of backflow or backsiphonage is installed, it shall have first been certified by a recognized testing laboratory acceptable to the Administrative Authority. Devices installed in a building potable water supply distribution system for protection against backflow shall be maintained in good working condition by the person or persons responsible for the maintenance of the system. The Administrative Authority having jurisdiction shall routinely inspect such devices and if found to be defective or inoperative shall require the replacement thereof.

5. Installation of Devices.

Vacuum Breakers: Vacuum breakers shall be installed with the critical level at least six (6) inches above the flood level rim of the fixture they serve and on the discharge side of the last control valve to the fixture. No shut-off valve or faucet shall be installed beyond the vacuum breaker. For closed equipment or vessels such as pressure sterilizers the top of the vessel shall be treated as the flood level rim but a check valve shall be installed on the discharge side of the vacuum breaker.

Reduced Pressure Zone Backflow: A reduced pressure zone type backflow preventer may be installed subject to full static pressure.

2.14: continued

Devices of all Types: Backflow and backsiphonage preventing devices shall be accessibly located preferably in the same room with the fixture they serve. Installation in utility or service spaces, provided they are readily accessible, is also permitted.

6. Tanks and Vats -- Below Rim Supply. Where a potable water outlet terminates below the rim of a tank or vat and the tank or vat has an overflow of diameter not less than given on Table 5 in 248 CMR 2.14, "Sizes of Overflow Pipes for Water Supply Tanks," the overflow pipe shall be provided with an air gap as close to the tank as possible.

The potable water outlet to the tank or vat shall terminate a distance not less than 1 1/2 times the height to which water can rise in the tank above the top of the overflow. This level shall be established at the maximum flow rate of the supply to the tank or vat and with all outlets except the air gap, overflow outlet closed.

The distance from the outlet to the high water level shall be measured from the critical point of the potable water supply outlet.

7. Protective Devices Required. Approved devices to protect against backflow and backsiphonage shall be installed at all fixtures and equipment where backflow and/or back siphonage may occur and where a minimum air gap cannot be provided between the water outlet to the fixture or equipment and its flood level rim.

Connections Not Subject to Back Pressure. Where a water connection is not subject to back pressure, a non-pressure type vacuum breaker shall be installed on the discharge side of the last valve on the line serving the fixture or equipment. A list of some conditions requiring protective devices of this kind is given in Table 8 in 248 CMR 2.14 -- Cross Connections Where Protective Devices Are Required and Critical Level (C-L) Settings for Backflow Preventers.

8. Barometric Loop. Water connections not subject to back pressure where an actual or potential backflow or backsiphonage hazard exists may in lieu of devices specified in 248 CMR 2.14(6)(k)5., be provided with a barometric loop. Barometric loops shall precede the point of connection.

2.14: continued

TABLE 8

CROSS CONNECTIONS WHERE PROTECTIVE DEVICES ARE REQUIRED AND CRITICAL LEVEL (C-L) SETTINGS FOR BACKFLOW PREVENTERS[1]

Fixture or Equipment	Method of Installation
Aspirators and ejectors	C-L at least 6" above flood level of receptacle.
Dental units	On models without built-in vacuum breakers -- C-L at least 6" above flood level rim of bowl.
Dishwashing machines	C-L at least 6" above flood level of machine. Install on both hot and cold water supply lines.
Flushometers (closet and urinal)	C-L at least 6" above top of fixture supplied.
Garbage can cleaning machine	C-L at least 6" above flood level of machine. Install on both hot and cold water supply lines.
Hose outlets	C-L at least 6" above highest point on hose line.
Laundry machines	C-L at least 6" above flood level of machine. Install on both hot and cold water supply lines.
Lawn sprinklers	C-L at least 12" above highest sprinkler or discharge outlet.
Steam tables	C-L at least 6" above flood level.
Tank and vats	C-L at least 6" above flood level rim or line.
Trough urinals	C-L at least 30" above perforated flush pipe.
Flush tanks	Equip with approved ball cock. Where ball cocks touch tank water equip with vacuum breaker at least 1" above overflow outlets. Where ball cock does not touch tank water install ball cock outlet at least 1" above overflow outlet or provide vacuum breaker as specified above.

2.14: continued

(7) Hot Water Supply System. In residences and buildings intended for continuous occupancy, hot water shall be supplied to all plumbing fixtures and equipment used for bathing, washing, culinary purpose, cleansing, laundry, or building maintenance.

(8) Hot Water Tanks or Heaters.

(a) Domestic Hot Water Storage Tanks and Tankless Heaters: Performance Efficiency.

1. All automatic, electric, domestic hot water storage tanks shall have a stand-by loss not exceeding 4 W/ft.^{2} of tank's surface area; when tested in accordance with ANSI STANDARD C72-1 entitled Household Automatic Electric Storage type heaters.

2. All gas and oil fired, domestic hot water storage tanks shall have a recovery efficiency (E^r) not less than 75 percent and a stand-by loss percentage (S) not exceeding:

$S = 2.3 + 67/V$

Where

V = rated volume in gallons

When tested in accordance with ANSI Standard 221.10.3-74 Gas Water Heaters Volume III, circulating tank, instantaneous and large automatic storage type water heaters.

EXCEPTIONS: All gas and oil fired heaters over 80 gallons capacity are exempt from the requirement on recovery efficiency. When using Std. RE-7, oil fired units have a CF = 1.0; Q equals total gallons of oil consumed; and H equals total heating value of oil in Btu/gal.

a. All gas and oil fired heaters with a Btu/h input rate over 75,000 are exempt from the requirements on recovery efficiency.

b. When using ANSI Z21.10.3-74, oil fired units have a CF = 1.0; Q equals total gallons of oil consumed; and H equals total heating value of oil in Btu/gal.

3. Insulation. Heat loss from unfired hot water storage tanks shall be limited to a maximum of 15 Btu/h/sq. ft. of external tank surface area. The design ambient temperature shall be no higher than 65°F for calculating heat losses.

4. Combination Domestic Hot Water/Space Heating Boilers. Service water heating equipment shall not be dependent upon year round operation of space heating boilers (that is, boilers that have winter space heating as another function).

EXCEPTIONS:

Exempt from these requirements are systems with Domestic Hot Water/Space Heating Boilers having a stand-by loss in Btu/h less than:

$$\frac{13.3\ pmd + 400}{n}$$

pmd = probably maximum demand

n = fraction of year when outdoor daily mean temperature exceeds 64.9°F.

The stand-by loss is to be determined for a test period of 24 hour duration while maintaining a boiler water temperature of 90°F above ambient.

5. Temperature Controls.

- Domestic hot water systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use.
- Shut down: A separate switch shall be provided to permit turning off the energy supplied to electric domestic hot water

2.14: continued

systems. A separate valve shall be provided to permit turning off the fuel supplied to the main burner(s) of all other types of domestic hot water systems.

(b) Minimum Capacity. The minimum capacity of a hot water storage tank or heater shall be based upon the hot water demand of the building which is served; and in accordance with the generally accepted standards of engineering practice, and shall comply with the minimum standards of Article II of the State Sanitary Code, 105 CMR 410,000.

(c) Working Pressure of Storage Tank. To determine the working pressure of a hot water tank as required by Section 18E of Chapter 142 of the General Laws, the street or service pressure only shall be considered, unless a water pressure booster system is used to raise the house pressure above the street pressure.

(d) Tank Drains. A storage tank shall be equipped with a brass drain cock or valve for emptying at the lowest point or a valve or cock approved by the Board of State Examiners of Plumbers and Gas Fitters.

(e) Cold Water Supply. A check valve shall not be installed in the cold water supply to any hot water storage tank, unless specifically permitted in writing by the Board. Thermal check valves having a minimum of 1/8 diameter hole drilled in the clapper are permitted.

(f) Conservation of Hot Water.

1. Showers: Showers used for other than safety reasons shall be equipped with approved flow control devices to limit total flow to a maximum of 3 gpm per shower head.

EXCEPTION: This requirement shall not apply to installations where showers are supplied with two or three valve diverters.

2. Lavatories in restrooms of public facilities shall
- Be equipped with outlet devices which limit the flow of domestic hot water to a maximum of 0.5 gpm.
- Be equipped with devices which limit the outlet temperature to a maximum of 110°F.
- Be equipped with metering faucets that limit delivery to a maximum of 0.25 gal. of hot water.

(g) Conservation of Cold Water. Tank type water closets-maximum 3 gallons (11.4 liters) per flush; (2) Flushometer water closets-maximum 3½ gallons (13.3) per flush; (3) Flushometer urinals-maximum 1.5 gallons (5.7 liters) per flush. The provisions of this section shall apply to all new construction as well as to renovations and replacement in existing structures after the effective date of this act. In satisfaction of the requirements of this section, the examiners shall permit the installation of tank-type water closets equipped with devices which are found by the examiners to meet applicable standards, in water closets having a tank capacity in excess of 3 gallons.

(11.4 liters). The examiners may also allow the use of standard flush water closets and urinals which do not meet the specific standards when, in the opinion of the examiners, the configuration of the building drainage system requires a greater quantity of water to adequately flush the system. The examiners shall publish or cause to be published, periodically, a list of acceptable fixtures and devices which comply with applicable standards.

(9) Prohibited Methods of Water Heating.

(a) Hot Water Generators. No coils, boosters or other hot water heating devices shall be installed in direct contact with the heat generating source of any building heating system or heating unit.

(b) Systems Without Automatic Control. No domestic hot water storage system, connected with or to, a direct heating device or appliance, shall be installed in any basement of any building or other unattended area unless such installation has fully automatic

2.14: continued

control to prevent raising of the temperature of the water in any part of the storage tank to 212 degrees Fahrenheit.

(10) Return Circulation -- Where Required. Hot water supply systems in buildings where the developed length of hot water piping from the source of hot water supply to the farthest fixture supply exceeds 100 feet shall be of the total return circulation type.

(11) Safety Devices for Hot Water Tanks.

(a) Safety devices to be used on hot water tanks and tankless heaters shall be installed to comply with the provisions of Section 19 of Chapter 142 of the General Laws and Standard ANSI 221.22 latest issue.

(b) Pressure Relief Valves. *Pressure relief valves installed on direct-fired heaters up to 200,000 BTU per hour input shall have a listed rating of not less than the heater input. Minimum valve size shall be 3/4" except that heaters with input of 15,000 BTU per hour or less may have ½" size vaves installed. *Except for tankless heaters. See Table 9 in 248 CMR 2.14.

For tankless heaters connected to low pressure steam and hot water heating boilers, the pressure relief valve shall be sized as follows:

2.14: continued

TABLE 9

Heater Rating Gal per Min	Valve Size
Up to 5	1/2"
Over 5 up to 20	3/4"
Standard Z21.22 applies	
Over 20 up to 50	1"
Over 50	1-1 1/4"
A.S.M.E. Standard applies	

(c) Temperature Relief Valves. Temperature Relief Valves shall meet the requirements of Section 19 of Chapter 142 of the General Laws and Standard ANSI Z21.22 latest issue.

Valves shall be minimum 3/4" size except that for heaters with input of 15,000 BTU per hour or less, the valve can be 1/2" size.

The automatic Temperature Relief Valve shall be self-closing and be equipped with the testing lever and extended thermostatic relieving element at least 8" long. Said valve shall have a minimum discharge in BTU per hour at least equal to the heater input. When the water heater is furnished with a separate relief valve tapping in the side and within the top 6" of the tank, the valve installed in such tapping may be equipped with either an extension or short themostatic element.

The official A.G.A. listed rating of an approved valve will be considered in compliance with the requirements of this Section.

(d) Combination Temperature & Pressure Relief Valves. A combination temperature and pressure relief valve shall meet the requirements of both the temperature and pressure relief valves as provided in 248 CMR 2.14(11)(b) and 2.14(11)(c).

For heaters over 200,000 BTU/Hr., input rating, the valve shall have a minimum A.G.A. temperature steam rating of 200,000 BTU, shall comply with all construction and testing requirements of the current ANSI Standard Z21.22, shall have minimum 1" inlet and outlet pipe connections, and shall be ASME pressure steam rated. A temperature water rating, on the basis of 1250 BTU for each gallon per hour of water discharged at 30 lbs. working pressure and a maximum temperature of 210° F., will be acceptable for the temperature rating for heaters over 200,000 BTU/Hr. input rating. This rating must be certified by the valve manufacturer and must not be more than the ASME rating shown.

(e) Vacuum Relief Valves. Water heaters and storage tanks shall be protected against loss of water from siphoning due to loss of supply pressure by a vacuum relief valve installed in the cold water supply line at a level above the top of the heater or tank. Where heating equipment has a bottom supply, the cold water supply piping shall be carried above the top of the heater before dropping down to the supply connection and have a vacuum relief valve installed in it at a level above the top of the storage tank. The vacuum relief valve shall be in compliance with the Standard ANSI Z21.22 at latest issue.

Valves marked with the A.G.A. symbol and listed by the American Gas Association Laboratories will be considered in compliance with this Section. Valves shall have minimum *1/2" diameter orifice and the air inlet opening on any vacuum valve shall not be smaller than the nominal pipe size of the valve. *Note: Vacuum relief valves shall be sized so as to have a cross sectional area equal to a pipe not less than one pipe size smaller than the tank supply or drain, whichever is larger. Vacuum relief valves may be installed in multiples.

2.14: continued

(12) Section 17, Chapter 142, General Laws. No range boiler, tank, vessel or container, ferrous or nonferrous, in which water is to be heated or stored under pressure for domestic, culinary or sanitary purposes, in this section and in sections eighteen and nineteen referred to as hot water tanks, shall be sold or offered for sale unless it is plainly marked by the manufacturer, by stamping into the metal of the tank, or on a metal plate permanently attached to the tank in a conspicuous place, as follows:

(a) Manufacturer's name or registered trademark,

(b) Rated capacity of hot water tank in United States gallons.

(c) Hydrostatic pressure in pounds per square inch at which the tank has been tested by the manufacturer, following the words "Tested to,"

(d) Maximum allowable working pressure in pounds per square inch.

Notwithstanding the requirements of the preliminary paragraph and paragraphs (a) to (d), inclusive, of this subsection, the marking therein referred to shall not be required, in the case of cast iron hot water fronts, so called, or hot water tanks that are insulated or enclosed in a jacket or casing, to be stamped into the metal thereof or to be stamped on a metal plate permanently atttached thereto; provided, that any manufacturer selling such hot water fronts within the Commonwealth shall in writing certify to the Department of Public Safety and the Board of State Examiners of Plumbers that every such water front sold by him complies with the pertinent provisions of law; and provided, further, that any manufacturer of hot water tanks that are insulated or enclosed in a jacket or casing which are to be sold within the Commonwealth shall certify in writing to the Department of Public Safety and the Board of State Examiners of Plumbers that every such tankless water heater coil or element, or shall permanently attach to the largest segment of said jacket or casing, in a conspicuous place, a metal plate which has stamped into the metal thereof the requirements of paragraphs (a) to (d) inclusive.

(13) Section 18, Chapter 142, General Laws. No hot water tank shall be repaired, relocated or installed and connected, unless it meets the following construction requirements:

(a) The actual capacity of a hot water tank shall be within seven and one-half per cent of the capacity stamped on the tank.

(b) A hot water tank shall be so constructed by riveting, welding, or otherwise, as to withstand the stamped test pressure without visible permanent distortion and be so designed as to have an ultimate strength sufficient to withstand a hydrostatic pressure twenty-five per cent higher than the stamped test pressure.

(c) Solder which melts at a temperature below seven hundred degrees Fahrenheit shall not be used to hold the tank together, but may be used to make it watertight, cistern tanks excepted.

(d) A hot water tank in which water is to be heated or stored under pressure greater than fifteen pounds per square inch shall have a stamped test pressure of not less than two hundred pounds per square inch.

(e) The maximum working pressure at which a hot water tank may be installed shall not be greater than fifty per cent of the test pressure marked on the tank.

(14) Section 19, Chapter 142, General Laws. No hot water tank shall be installed and connected unless it is protected with safety devices as follows:

(a) A hot water tank in which water is to be heated or stored under pressure greater than fifteen pounds per square inch shall be equipped with a suitable pressure relief valve installed in a tapping in the tank or in the cold water supply line, or the hot water outlet line, with no shut-off valve between the relief valve and the tank. The pressure relief valve shall be set by the

2.14: continued

manufacturer to operate at a pressure not more than the maximum working pressure stamped on the tank, jacket or casing, and shall be so constructed that said setting cannot be exceeded by normal means of adjustment.

(b) A hot water tank to which a heating device or appliance capable of delivering water to the tank at a temperature greater than two hundred and twelve degrees Fahrenheit is connected shall be equipped with a suitable temperature relief valve so adjusted and installed as to prevent development of, or accumulation of, water which is at a temperature in excess of two hundred and twelve degrees Fahrenheit. Said temperature relief valve shall be installed in a tapping directly in or on the tank, within twelve inches of the top of a vertical tank, or within six inches of the top of a horizontal tank, with no fittings between the valve and tank, except that a bushing may be used to reduce the tapping to fit the valve, or the valve shall be installed in the hot water outlet pipe as close to the top of the tank as possible. In no case shall the heat sensitive member of the temperature relief valve be more than five inches away from the top of the tank. The discharge outlet of the temperature relief valve shall be connected by means of a non-ferrous pipe or tubing not less than the size of the outlet ot the discharge outlet with, no shut off, to an open plumbing, or to within twelve inches of the basement floor or under acceptable terminal approved by the Board of State Examiners of Plumbers and Gas Fitters. A thermostatically controlled hot water tank may be protected by an automatic fuel shut off device in addition to the thermostat. Such shut off device shall be installed in the same location and perform the same function as said temperature relief valve.

(c) All parts of temperature and pressure relief valves which are in contact with water shall be made of non-ferrous metals or materials having suitable corrosion resisting properties. All pipe and fittings between relief valves and the hot water tank shall be of non-ferrous metals.

(d) Relief valves shall be marked by the manufacturer, by stamping or casting in the metal of the valve, or on a metal tag permanently attached to the valve, as follows:

1. Manufacturer's name or registered trade mark.
2. The type or style, or the type and style, of the valve.
3. The pressure setting of the valve in pounds per square inch.
4. The temperature setting in degrees Fahrenheit.
5. Temperature relieving capacity B.T.U. per hour.

Notwithstanding the requirements of 248 CMR 2.14(14)(b), the protective devices specified therein shall not be required in the case of that portion of tankless water heaters which contain water to be heated or stored under the provisions of section seventeen. Said portion of tankless water heaters shall be equipped with a pressure relief valve and an approved individual thermostatic and/or pressure balance device, set to deliver water not exceeding one hundred and eighty degrees Fahrenheit and located between said tankless water heater and any hot water supply pipe which it serves.

All pipes and fittings between the tankless water heater and the pressure relief valve and the tempering device shall be non-ferrous metals or other materials having suitable corrosion resisting properties. Said tempering device shall be marked by the manufacturer by casting or stamping in the metal of the device, or on a metal tag permanently attached to the device, as follows:

1. Manufacturer's name or registered trade mark.
2. The type or style, or the type and style, of the device.
3. The temperature settings, in degrees Fahrenheit, plainly marked.

2.14: continued

(e) Temperature and pressure relief valves and other devices referred to in this section shall be subject to the approval of the Inspectors of Plumbing or other proper authorities.
(f) All pipes and fittings in the circulating system between a hot water tank and the heating device or appliance shall be nonferrous, and of ample size so as to make it possible to heat seventy-five per cent of the available water in the tank without raising the temperature of any part of the water above two hundred and twelve degrees Fahrenheit.
(g) No hot water tank shall be installed without being equipped with an approved device located so as to prevent any partial vacuum therein.

(15) Disinfection of Potable Water System Piping. When necessary, the Inspector of Plumbing shall require that a potable water system, or any part thereof, which has been installed or repaired, be disinfected in accordance with one of the following methods before it is placed in operation:

The system, or part thereof, shall be filled with a water and chlorine solution which contains fifty (50) parts per million of available chlorine; and the same shall then be allowed to stand six (6) hours before the system, or part thereof, is flushed and returned to service. The system, or part thereof, shall be filled with a solution which contains one hundred (100) parts per million of available chlorine; and the same shall then be allowed to stand two (2) hours before the system, or part thereof, is flushed and returned to service.

Where it is not possible to disinfect a potable water storage tank as provided above, the entire interior of the tank shall be swabbed with a solution which contains two hundred (200) parts per million of available chlorine; and the solution shall then be allowed to stand two (2) hours before the tank is flushed and returned to service. For a potable water filter or similar device, the dosage shall be determined by the Massachusetts Department of Environmental Quality Engineering.

2.15: Sanitary Drainage System

(1) Materials. Pipe, tubing, fittings, and traps to be used on any part of the sanitary drainage system in a building or adjacent to a building shall comply with 248 CMR 2.06, 2.07 and 2.08.

(2) Determining Size of Drainage System.
(a) Load on Drainage Piping. The load on drainage system piping shall be computed in terms of drainage fixture units in accordance with Table 1 in 248 CMR 2.15 and 248 CMR 2.15(2)(b).
(b) Values for Continuous Flow. Fixture unit values for continuous or semi-continuous flow into a drainage system, such as from a pump, sump ejector, air conditioning equipment, or similar device shall be computed on the basis of two fixture units for each gallon per minute of flow.

(3) Selecting Size of Drainage Piping. Pipe sizes shall be determined from Tables 2, 3, and 4 in 248 CMR 2.15 on the basis of drainage load computed from Table 1 in 248 CMR 2.15 and 248 CMR 2.15(2)(b).

(4) Minimum Size of Soil and Waste Stacks. No soil or waste stack shall be smaller than the largest horizontal branch connected thereto except that a 4 x 3 W.C. connection shall not be considered as a reduction in pipe size.

(5) Minimum Size of Stack Vent or Vent Stack. Any structure in which a building drain is installed, shall have at least one (1) stack vent or vent stack not less than three (3) inches in diameter, which shall be carried full size through the roof.

2.15: continued

(6) Provision for Future Fixtures. When provision is made for future installation of fixtures, those provided for shall be considered in determining the required sizes of drain and vent pipes. Construction to provide for such future installations shall be terminated with a plugged fitting or fittings.

(7) Size of Underground Drainage Piping.

(a) Underground or Basement Floor. No portion of the drainage system installed underground or below a basement floor, shall be less than two (2) inches in diameter.

(b) Sanitary Piping Through Foundation. Sanitary pipes passing through an exterior foundation wall shall be at least four (4) inches in diameter, except when serving a Special Waste (248 CMR 2.13), or serving a domestic laundry wasting to a separate disposal system, or when serving as the waste for a Sacrarium (248 CMR 2.10(17)).

TABLE 1

FIXTURE UNIT VALUES FOR
VARIOUS PLUMBING FIXTURES

Type of fixture or group of fixtures	Fixture
Automatic clothes washer (1 1/2" standpipe)	2
Automatic clothes washer (2" standpipe)	3
Bathroom group consisting of a water closet, lavatory and bathtub or shower stall:	
Flushometer valve closet	8
Tank type closet	6
Bathtub[1] (with or without overhead shower)	2
Bidet	3
Combination sink-and-tray with food disposal unit	4
Combination sink-and-tray with one 1½" trap	2
Combination sink-and tray with separate 1½" traps	3
Dental unit or cuspidor	1
Dental lavatory	1
Drinking fountain	1/2
Dishwasher, domestic	1
Floor drains[2] with 2" waste	3
Kitchen sink, domestic, with one 1 1/2" waste	2
Kitchen sink, domestic, with food waste grinder	2
Lavatory with 1 1/4" waste	1
Laundry tray (1 or 2 compartments)	2
Shower stall, domestic	2
Showers (group) per head	2
Sinks:	
Surgeons	3
Flushing rim (with valve)	6
Service (trap standard)	3
Service (P trap)	2
Pot, scullery, etc. (each section)	4
Urinal, pedestal, syphon jet blowout	6
Urinal, wall lip	4
Wash sink (circular or multiple) each 20 inches of usable length	1
Water closet, tank-operated	4
Water closet, valve-operated	6

2.15: continued

TABLE 1 (continued)

FIXTURE UNIT VALUES FOR
VARIOUS PLUMBING FIXTURES

Type of fixture or group of fixtures	Fixture
Unlisted fixture drain or trap size:	
1 1/4" or less	1
1 1/2"	2
2"	3
2 1/2"	4
3"	5
4"	6

Note 1: A shower head over a bathtub does not increase the fixture value.
Note 2: See 248 CMR 2.15(2)(b) for method of computing unit value of devices with continuous or semi-continuous flows.
Note 3: Size of floor drain shall be determined by the area of surface to be drained.

TABLE 2.

MAXIMUM LOADS IN FIXTURE UNITS FOR HORIZONTAL DRAINS

Diameter of drain (inches)	Horizontal fixture branch[1] (f.u.)	Building drain or building sewer[2] 1/8 in./ft. (f.u.)	1/4 in./ft. (f.u.)	1/2 in./ft. (f.u.)
1½	3	---	---	---
2	6	---	---	---
2½	12	---	---	---
3	34[3 - 4]	---	40[3 - 4]	48[3 - 4]
4	160	180	216	250
5	360	390	480	575
6	620	700	840	1,000
8	1,400	1,600	1,920	2,300
10	2,500	2,900	3,500	4,200
12	3,900	4,600	5,600	6,700
15	7,000	8,300	10,000	12,000

Note 1: Does NOT include branches to the building drain.
Note 2: DOES include branches to the building drain.
Note 3: Not over two water closets or bathroom groups on a horizontal fixture branch nor more than three waterclosets or bathroom groups on a branch of the building drain.
Note 4: Not more than 3 waterclosets or 3 bathroom groups on a 3" building drain.

TABLE 3

MAXIMUM LOADS IN FIXTURE UNITS FOR SOIL AND WASTE
STACKS HAVING 1 or 2 BRANCH INTERVALS

Diameter of stack (inches)	Maximum load on stack (f.u.)	Diameter of stack (inches)	Maximum load on stack (f.u.)
1½	4	6	930
2	8	8	2,100
2½	20	10	3,750
3	48[1]	12	5,850
4	240	15	10,500
5	540		

Note 1: Not more than 2 water closets or bathroom groups within each branch interval nor more than 3 water closets or bathroom groups on the stack.

2.15: continued

TABLE 4

MAXIMUM LOADS IN FIXTURE UNITS FOR ANY ONE BRANCH INTERVAL ON MULTISTORY SOIL AND WASTE STACKS[1]

Diameter of Stack	Number of branch intervals													Load Limit for Tall Stacks
	3	4	5	6	7	8	9	10	11	12	13	14	15	
2	3	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	10
2 1/2	8	7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	28
3[2]	20	18	17	16	15	14	13	12	11	10	10	10	10	102[3]
4	100	90	84	80	77	75	73	72	71	70	69	68	68	530
5	225	205	190	180	175	170	165	162	159	157	156	154	153	1,400
6	385	350	325	310	300	290	285	280	275	271	268	266	263	2,900
8	875	785	735	700	675	655	640	630	620	612	606	600	594	7,600
10	1,560	1,405	1,310	1,250	1,205	1,170	1,140	1,125	1,110	1,095	1,080	1,075	1,062	15,000
12	2,435	2,195	2,045	1,950	1,875	1,825	1,790	1,755	1,730	1,705	1,685	1,670	1,655	26,000
15	4,375	3,935	3,675	3,500	3,380	3,280	3,210	3,150	3,110	3,060	3,030	3,000	2,975	50,000

[1] These limits are applicable only when the maximum load within any 1 branch interval is not greater than $N\left(\frac{1}{2n} + \frac{1}{4}\right)$ Where N=permissible load on a stack of 1 or 2 branch intervals, and n=number of branch intervals on the stack under consideration.

[2] Not more than 2 water closets or bathroom groups within each branch interval nor more than 3 water closets or bathroom groups on the stack.

[3] The formula contained in footnote 1 does not apply to 3" stacks. For 3" stacks above 15 intervals, no single interval shall exceed more than 10 fixture units.

Max. F.V. Conn. branch interval $= \frac{N}{2n} + \frac{N}{4}$ E.g. Find the maximum number of fixture units which can be connected to a 4'' stack at any branch interval $= \frac{240}{2(10)} + \frac{240}{4} = 12 + 60 = 72$

2.15: continued

(8) Sizing of Offsets on Drainage Piping.

(a) Offsets of 45 Degrees or Less. An offset in a vertical stack with a change of direction of 45 degrees or less from the vertical, may be sized as a straight vertical stack. In case a horizontal branch connects to the stack within 2 feet above or below the offset, a relief vent shall be installed in accordance with 248 CMR 2.16(4)(c).

(b) Offsets of More than 45 Degrees. A stack with an offset of more than 45 degrees from the vertical shall be sized as follows: The portion of the stack above the offset shall be sized as for a regular stack based on the total number of fixture units above the offset.

The offset shall be sized as for a building drain as shown in Table 2 in 248 CMR 2.15.

The portion of the stack below the offset shall be sized as for the offset or based on the total number of fixture units on the entire stack, whichever is the larger.

In buildings of 5 stories or more a relief vent for the offset shall be installed as provided elsewhere in 248 CMR 2.16(4)(c) and in no case shall a horizontal branch connect to the offset or to the stack within 2 feet above or below the offset.

(c) Above Highest Branch. An offset above the highest horizontal branch is an offset in the stack-vent and shall be considered only as it affects the developed length of the vent.

(d) Below Lowest Branch. In the case of an offset in a soil or waste stack below the lowest horizontal branch, there shall be no change in diameter required if the offset is made at an angle of not greater than 45 degrees. If such an offset is made at an angle greater than 45 degrees to the vertical, the required diameter of the offset and the stack below it shall be determined as for a building drain in Table 2 in 248 CMR 2.15.

(9) Drainage Piping Installations. See 248 CMR 2.05 --- General Regulations for the following: ---

1. Pitch of horizontal piping.
2. Fittings used to change diretion.
3. Prohibited fittings.
4. Heel or side inlet bends.
5. Obstructions to flow.
6. Dead ends.

(a) Kitchen Sink Wastes (Domestic). Not less than a one and one-half (1 1/2) inch branch waste and/or waste outlet shall be provided to receive the fixture drain from a kitchen sink, which shall connect indpendently to the sanitary drainage system. A kitchen sink shall not waste into a horizontal branch drain or waste serving a bathtub or similar flat bottom fixture, that is smaller than three (3) inches in diameter.

(b) Roughing -- Food Waste Disposer. The fittings used in any sanitary drainage system to receive the fixture waste from a kitchen sink, shall be installed at a height to permit the installation of a food waste disposer. Said fitting shall be so installed, regardless as to when if ever, the food waste disposer is to be installed.

(10) Sumps and Ejectors.

(a) Building Drains Below Building Sewer. Building drains which cannot be discharged to the sewer by gravity flow shall be discharged into a tightly covered and vented sump, from which the contents shall be lifted and discharged into the building gravity drainage system by automatic pumping equipment or by any equally efficient method approved by the Inspector. Only drains located below the sewer shall discharge into sumps. All other drains shall be discharged by gravity.

2.15: continued

(b) Design of Sumps and Ejectors. Sump and pumping equipment shall be so designed as to discharge all contents accumulated in the sump during the cycle of emptying operation and the storage of drainage in a sump or ejector shall not exceed twelve (12) hours.
(c) Duplex Equipment. Sumps or ejectors, in other than one or two family houses or residences, receiving the discharge of six (6) or more water closets shall be provided with duplex pumping equipment.
(d) Drainage Pipe Venting. The system of drainage piping below the sewer level shall be installed and vented in a like manner to that of the gravity system to conform with 248 CMR 2.16.
(e) Prohibited Connections to Discharge Pipe. No fixtures or drains shall be connected to the discharge pipe from an ejector or pump between the ejector or pump and the point where it enters the building drain or sewer.
(f) Backflow Prevention. All sumps and ejectors shall be protected against backflow and/or backpressure from the building sewer or drain by installing a backwater or check valve in the discharge pipe from the ejector or sump pump. This protection will also comply with 248 CMR 2.09 (2)(b).
(g) Size of Sumps and Pumps. All sumps shall have a holding capacity sufficient to meet the demand of a period not to exceed twelve (12) hours. In single family dwellings, a sewage ejector or sump pump receiving the discharge of water closets and other fixtures, shall have a minimum discharge capacity of twenty (20) gallons per minute. In all other installations, ejectors and sump pumps shall be sized in conformance with Table 5 in 248 CMR 2.15.

TABLE 5
DETERMINING CAPACITIES OF
SEWAGE EJECTORS

In order to calculate the capacities of pumps used in Sewage Ejectors, it is recommended the following procedures be used in all classes of buildings. The safety factors included in the tables here given, are sufficient to take care of all installations. Any installation that does not meet the requirements of this Table shall require the approval of the Board of State Examiners of Plumbers and Gas Fitters.

Number of Water Closets to be Served by each Ejector	G.P.M. Discharge of each Pump
1 - 3	75
4 - 5	100
6 - 7	125
8 - 10	150
11 - 15	200
16 - 20	250
21 - 25	300
26 - 30	350
31 - 35	375

EJECTORS HANDLING OTHER FIXTURES

Generally, there will be a certain amount of fixtures other than water closetsemptying into the ejector sump. If the total amount of these fixtures exceed 4 times the amount of water closets used, the GMP of the ejector pump

2.15: continued

should be increased at the rate of 3 GPM for each fixture in excess of 4 times the amount of water closets.

EXAMPLE:

GPM Pump Discharge of 4 Toilets	100 GPM
Number of additional fixtures to be handled.	20
Excess Fixtures as calculated from above 20 - (4 x 4) = 4	4
Four @ 3 GPM	12 GPM
Correct Sewage Ejector Pump to use	112 GPM

(h) Individual Fixture Pumps. Individual fixtures other than water closets, urinals, or similar fixtures may discharge directly into an approved fixture mounted pump or into receivers with ejectors or pumps. The discharge piping from the pump shall have a back-water or check valve to prevent the discharged waste from returning to the pump. Direct mounted equipment may be manually or automatically operated. Installation of either type equipment is not subject to venting requirements of this Code, but subject only to venting necessary for proper operation of equipment, and vents on fixture side of trap may terminate locally in area served. If equipment provides a proper water seal, additional traps are not required.

2.16: Vents and Venting

(1) Materials.

(a) Above and Below Ground. All pipe and fittings to be used on the venting system, or any part thereof, shall comply with 248 CMR 2.06 of this Code.

(b) Chemical Waste Systems. Vent piping on chemical and corrosive waste systems shall conform to that required for Special Wastes under 248 CMR 2.13.

(2) Prohibited Venting.

(a) Bow Vents. Bow vents are not permitted, except with special permission from the Inspector, and only then for so called "island" fixture installations. If and when such permission is granted, a bow vent system as designed by the Board shall be used.

(b) Combination Waste and Vent. A combination waste and vent system shall not be used unless no other system is possible or practicable, and only then with special permission from the Examiners.

(c) Crown Venting Limitation. No vent shall be installed within two (2) pipe diameters of the trap weir.

(d) Extension of Horizontal Drain. The extension or continuation of a horizontal soil or waste pipe shall not serve as a vent, except when permitted under wet venting, or when a fixture waste of not more than two (2) fixture units is connected, with approval, to the vertical extension of the extended horizontal piping.

(e) Below Trap Weir. The vent pipe opening from a soil or waste pipe, except for water closets and similar fixtures, shall not be below the weir of the trap.

(f) Use Other than Venting. The plumbing vent system shall not be used for purposes other than the venting of the plumbing system.

(3) Protection of Trap Seals. The protection of trap seals from siphonage or back pressure shall be accomplished by the appropriate use of soil or waste stacks, vents, revents, back vents, dry vents, wet vents, loop vents, circuit or continuous vents, or combinations thereof, installed in accordance with the requirements of this section, so that at no time shall the trap be subjected to a pressure differential of more than 1 inch of water.

2.16: continued

(4) Vent Stacks and Stack Vents.

(a) Vent Stack Required. Every building in which plumbing is installed shall have at least one main stack, which shall run undiminished in size and as directly as possible, from the building drain through to the open air above the roof. A vent stack or a main vent shall be installed with a soil or waste stack whenever back vents, relief vents, or other branch vents are required in a building of three or more branch intervals.

(b) Connections at Base and Top. All main vents or vent stacks shall connect full size at their base to the drainage of the building or to the main soil or waste pipe, at or below the lowest fixture branch. All vent pipes shall extend undiminished in size above the roof, or shall be reconnected with the main soil or waste stack above the highest fixture connection discharging into it. The minimum size of any vent through the roof shall be 2 inches in diameter.

(c) Offsets in Building Five or More Stories. Except as provided in 248 CMR 2.15, offsets of less than 45 degrees from the horizontal in a soil or waste stack may be vented as two separate soil or waste stacks and may be vented by installing a relief vent as a vertical continuation of the lower section of the stack or as a side vent connected to the lower section between the offset and the next lower fixture or horizontal branch. The upper section of the offset shall be provided with a yoke vent. The diameter of the vents shall not be less than the diameter of the main vent, or of the soil and waste stack, whichever is the smaller.

(d) Vent Headers. Where vent stacks and stack vents connect to a vent header, such connections shall be made at the top of the stacks. The vent header shall connect to a vent extension through the roof. When more than two 4" soil or waste stacks are connected, vent header extension through the roof shall be 5" diameter, more than four 4" stacks, diameter shall be 6".

(e) Relief Vents for Vents of More Than Ten Branch Intervals. Soil and waste stacks in buildings having more than 10 branch intervals shall be provided with a relief vent at each tenth interval installed, beginning with the top floor. The size of the relief vent shall be equal to the size of the vent stack to which it connects. The lower end of each relief vent shall connect to the soil or waste stack through a wye below the horizontal branch serving the floor and the upper end shall connect to the vent stack through a wye not less than 3 feet above the floor level.

(5) Vent Terminals.

(a) Extension Above Roof. The vent extension through a roof shall be at least two (2) inches in diameter and shall extend not more than 24" and not less than 18" through the roof; and if that roof is used for garden or similar purposes the vent shall extend at least eight feet above roof and be increased one pipe size.

1. Increaser. The change in the diameter of a vent terminal shall be made by the use of an increaser; and at least one (1) foot below the roof surface.

(b) Waterproof Flashings. Each vent terminal shall be made watertight with the roof by proper flashing.

(c) Flag Poling Prohibited. Vent terminals shall not be used for the purpose of flag poling, TV aerials, or similar purposes.

(d) Location of Vent Terminal. No vent terminal shall be located directly beneath any door, window, or other ventilating opening of the building or of an adjacent building nor shall any such vent terminal be within 10 feet horizontally of such an opening unless it is at least 2 feet above the top of such opening.

(e) Extensions Outside Building. No soil, waste, or vent pipe extension shall be run or placed on the outside of a wall any building, but shall be carried up inside the building.

2.16: continued

(f) Frost Closure. Where frost closure is likely to occur, each vent extension through a roof shall be at least three (3) inches in diameter.

(6) Vent Grades and Connections.

(a) Vent Grade. All vent and branch vent pipes shall be so graded and connected as to drain back to the soil or waste pipe by gravity.

(b) Vertical Rise. Where vent pipes connect to a horizontal soil or waste pipe, the vent shall be taken off above the center line of the soil or waste pipe. The vent pipe shall rise vertically, or at an angle not more than 45 degrees from the vertical, to a point at least 6 inches above the flood-level rim of the fixture it is venting, before offsetting horizontally or before connecting to the branch vent. If it is not possible or practical to vent the fixture trap as required above, a vent serving a floor drain, floor sink, or similar floor mounted fixture may be extended horizontally below the water line of the fixture to the nearest practical location where it can rise. Said vent shall connect to soil or waste pipe above the center line not less than 45 degrees from the horizontal before running in a horizontal position.

(c) Height Above Fixtures. A connection between a vent pipe and a vent stack or stack-vent shall be made at least 6 inches above the flood-level rim of the highest fixture served by the vent. Horizontal vent pipes forming branch vents, relief vents, or loop vents shall be at least 6 inches above the flood-level rim of the highest fixture served.

(7) Wet Venting.

(a) Wet venting of fixture traps as hereinafter described may be used providing the entire sanitary waste and vent piping system meet all other code requirements.

(b) Bathtub or Shower Wet Vent. In a single bathroom having a common horizontal waste for lavatory and bath, a 2 inch waste and vent for the lavatory may serve as a wet vent for the bath.

(c) Double or Back to Back Bath Installations. In a double bathroom having a common horizontal waste for lavatories and baths, a 2 inch waste and vent for the lavatory may serve as a wet vent for the baths.

(d) Miscellaneous Wet Venting. A size two inch or larger waste and vent installed with approved drainage fittings may serve as a wet vent for a water closet, service sink, floor drain or similar fixture having a drain connection not less than three inches in diameter provided the lowest portion of any horizontal piping serving as a wet vent is above the top of any horizontal soil or waste piping being wet vented, except as specifically prohibited in 248 CMR 2.16 (7)(c).

Water closets in a bathroom below the top floor need not be individually vented if the 2" wet vented waste, serving the lavatories and bath tubs or showers connect directly into the branch for the water closet at or above the center line of the water closet drain.

(e) Piping Not to Serve as Wet Vents. A waste and vent for a kitchen sink, garbage disposal unit, dish washer, or other fixture installed for culinary use, or one that receives the discharge from a clothes washing machine may not serve as a wet vent for any other fixture.

(8) Stack Venting.

(a) Plumbing Fixtures on Top Interval (Three Inch Stack). A 3" soil or waste stack shall be sufficient for not more than forty-eight (48) fixture Units.

2.16: continued

Plumbing fixtures at the highest level may enter into not less than a three-inch (3") soil or waste stack without requiring any other vent other than the continuation of the three-inch (3") soil or waste stack as a vent through the roof or revented into the vent system above the highest fixture; provided that all such fixtures shall enter said stack independently; that the waste pipe from said fixtures shall have a pitch of not more than one-quarter inch (1/4) per foot; that the water closet and bathtub or shower drain connect to the stack at the same level; that the traps from said fixture shall be placed in compliance with Table 1 248 CMR 2.16.

(b) Stack Venting (Additional Stacks). Provided there is a soil and/or waste stack in a building as required under 248 CMR 2.16(4)(a), the continuation in an upwards direction of the vertical waste for a water closet may be reduced to two inch (2") and serve as the vent for the water closet and the waste for a lavatory, bath tub or shower stall, and a kitchen sink.

(c) Back to Back Installation (Stack Vented). Bathroom groups installed back to back are permissible provided they comply with the provisions of 248 CMR 2.16(8)(a).

(9) Common Vents.

(a) Individual Vent as Common Vent. An individual vent, installed vertically, may be used as a common vent for two fixture traps when both fixture drains connect with a vertical drain at the same level.

(b) Side by Side. If two bathtubs or similar flat bottom fixtures are installed back to back or side by side, a common vent may be used in a vertical position to serve as the vent for both fixtures.

(c) Different Levels. A vertical vent may be used for two fixtures that are located in the same branch interval but connected to the stack at different levels, not exceeding ten inches, provided

1. The vertical drain is one pipe diameter larger than the upper fixture drain but is not smaller than the lower fixture drain, whichever is the larger.
2. That both wastes for said fixtures conform to Table 1 in 248 CMR 2.16

(d) Fixtures Back-to-Back. Two fixtures set back-to-back, within the distance allowed between a trap and its vent, may be served with one continuous soil or waste vent pipe, provided that each fixture wastes separately into an approved double fitting having inlet openings at the same level.

(e) Horizontal Waste Branch. Two (2) lavatories or similar fixtures installed adjacent or back-to-back within six (6) feet of a main vented stack, proper wet vent, or continuous waste and vent, may be installed on a two (2) inch horizontal waste branch without reventing, provided the branch is not less than two (2) inches throughout its length and the fixture wastes are connected into the side center of the branch. Back-to-back waste connections shall be through fittings with sufficient directional flow design to assure separate entrance of each waste into the horizontal branch. The branch waste shall connect with its stack at a grade of not more than 1/4 inch per foot.

(10) Circuit and Loop Venting.

(a) Battery Venting. A horizontal branch soil or waste pipe that is uniformly sized to which two (2), but not more than eight (8) floor outlet water closets, pedestal urinals, trap standard to floor fixtures, showerstalls or floor drains, or any combination thereof, that are connected in battery and, discharge into the side center of the horizontal branch, may be vented by a circuit or loop vent, which shall be taken off in front of the last fixture connection of the battery. In addition, lower floor branches serving fixtures as described above, shall be provided with a relief vent taken off in

2.16: continued

front of the first fixture connection of the battery and shall connect from the top of the branch drain to the circuit or loop vent. When lavatories or similar fixtures discharge into such branches, the fixture wastes shall be provided with an individual or common vent. Batteries of more than eight (8) fixtures as described above may be installed, providing a vent as described above is installed for each eight (8) or less of the fixtures so connected.

(b) Dual Branches. When parallel branches serve fixtures as described in 248 CMR 2.16(a) all of the provisions and requirements of said 248 CMR 2.16(a) shall prevail, except that the fixture connections to each parallel horizontal branch shall be limited to fifty (50) percent (%) of the fixture connection permitted on a horizontal branch in 248 CMR 2.16(a).

(c) Vent Connections. When the circuit, loop or relief vent connections are taken off the horizontal branch, the vent branch connection shall be taken off at a vertical angle or from the top of the horizontal branch.

(d) Fixtures Back-to-Back in Battery. When fixtures are connected to one horizontal branch through a double wye or a sanitary tee in a vertical position, a common vent for each two fixtures back-to-back or double connection shall be provided. The common vent shall be installed in a vertical position as a continuation of the double connection.

(11) Fixture Vents

(a) Distance of Trap from Vent. Each fixture trap shall have a protecting vent so located that the slope and the developed length in the fixture drain from the trap weir to the vent fitting are within the requirements set forth in Table 1 in 248 CMR 2.16.

TABLE 1
DISTANCE OF FIXTURE
TRAP FROM VENT

Size of fixture drain, inches	Distance-Trap to Vent
1½	5 ft.
2	6 ft.
3	8 ft.
4	10 ft.

slope not to exceed ¼ inch per foot

(b) Venting of Fixture Drain Below Trap. The vent pipe openings from a soil or waste pipe, except for water closets and similar fixtures, shall not be below the top weir of the trap. An exception to this section will be permitted, with Inspector's approval, if the fixture has a flat bottom with a minimum area of 144 square inches. The horizontal section of the fixture waste must comply with Table 1 in 248 CMR 2.16 and the vertical section shall be at least one pipe size larger than the fixture trap and waste arm. The vent opening shall be as high and close to the fixture as possible and the vent piping shall be installed to comply with 248 CMR 2.16(6) of this Code.

(c) Floor-Mounted Fixture Outlet. On a floor outlet type water closet or similar fixture, distance shall not exceed 20" from the finish floor of the fixture served to the center line of the horizontal drain serving such fixture. If distance does exceed 20" said fixture shall be individually vented.

2.16: continued

(12) Size and Length of Vents.

(a) Size of Individual Vents. The minimum diameter of an individual vent shall be not less than one and one quarter (1¼) inches nor less than one-half (½) the diameter of the drain to which it connects.

(b) Size of Relief Vents. The diameter of a relief vent shall be not less than one-half (½) the diameter of the soil or waste branch to which it connects when fixtures are battery connected.

(c) Size of Circuit or Loop Vents. The diameter of a circuit or loop vent shall be not less than one-half (½) the diameter of the soil or waste branch to which it connects when fixtures are battery connected.

(d) Length of Vent Stacks. The length of the vent stack or main vent shall be its developed length from the lowest connection of the vent system with the soil stack, waste stack, or building drain, to the vent stack terminal in the open air.

(e) Size of Vents. The vent pipe sizes shall be determined from their length and the total number of fixture units connected thereto, as listed in Table 2 in 248 CMR 2.16. This table shall be used to size all vents, except for those vents that are specifically sized elsewhere in this Code.

(13) Future Venting. There shall be made available in the basement of every building, an accessible vent connection not less than two (2) inches in diameter, that is properly connected to the venting system to provide for venting of future plumbing. Said connection shall be labeled to identify its purpose and shall be drip connected.

(14) Combination Waste-and-Vent System.

(a) Special Permission Required. See 248 CMR 2.16(2)(b).

(b) Limited Installations. A combination waste-and-vent system is limited to the installation of floor drains and sinks. It consists of a wet vented installation of waste piping in which fixture drains are not individually vented. Every drainage pipe in a combination waste-and-vent system shall be not less than two (2) pipe sizes larger than the size required in 248 CMR 2.15.

(15) Venting of Sumps and Ejectors.

(a) Size of Vents. The size and length of all vent pipes serving building sumps and ejectors shall be determined from, and in accordance with Table 3 in 248 CMR 2.16.

(b) Pneumatic Ejector. The air pressure relief pipe from a pneumatic ejector shall not be connected to the regular venting system, but shall be vented independently to the atmosphere through the roof. The relief pipe shall be of sufficient size to relieve air pressure inside ejector atmospheric pressure within 10 seconds, but shall be not less than 1½ inches in diameter.

(c) Vent-Automatic. The automatic vent fitting shall be installed in the vertical position not less than 6" above the crown of the trap it serves. The piping distance from the trap outlet to the automatic vent fitting shall not be more than 12". The tail piece from the fixture to trap shall not be longer than 12". The automatic vent fitting shall be installed on the run of a T-Y in the vertical or branch of a T-Y in the horizontal with the T-Y installed so the direction of flow is with the flow of waste.

The automatic vent fitting shall be installed in a location readily accessible for inspection and replacement. It shall never be installed in a concealed location. Automatic vents are not permitted, except with special permission from the Board of State Examiners.

2.16: continued

TABLE 2
SIZE AND LENGTHS OF VENTS

Diameter of Soil of Waste Stack (in.)	Total Fixture Units Connected to Stack (dfu)	1¼	1½	2	2½	3	4	5	6	8	10
1½	4	50	150								
2	10	25	50	150							
2½	28		30	100	300						
3	7		42	150	360	1040					
3	21		32	110	270	810					
3	53		27	94	230	680					
3	102		25	86	210	620					
4	43			35	85	250	980				
4	140			27	65	200	750				
4	320			23	55	170	640				
4	530			21	50	150	580				
5	190				28	82	320	990			
5	490				21	63	250	760			
5	940				18	53	210	640			
5	1,400				16	49	190	590			
6	500					33	130	400	1,000		
6	1,100					26	100	310	780		
6	2,000					22	84	260	660		
6	2,900					20	77	240	600		
8	1,800						31	95	240	940	
8	3,400						24	73	190	720	
8	5,600						20	62	160	610	
8	7,600						18	56	140	560	
10	4,000							31	78	310	960
10	7,200							24	60	240	740
10	11,000							20	51	200	630
10	15,000							18	46	180	570

2.16: continued

Note for Table 2:

Note 1: This table shall also apply to the sizing of vents for branch soil and waste lines.

To determine size of vent, use the following procedure:

(1) Compute total number of fixture units, using Table 1 in 248 CMR 2.15 and 248 CMR 2.15(2)(b).

(2) Knowing total fixture unit load, refer to Table 3 in 248 CMR 2.15 or Table 4 in 248 CMR 2.15 depending on number of intervals, to determine size of stack.

(3) With selected stack size and total fixture unit load refer to Table 2 in 248 CMR 2.16 and determine size of vent. Follow same procedure to determine size of vents for branch soil and waste lines.

2.16: continued

TABLE 3
SIZE AND LENGTH OF SUMP VENTS[2]

Diameter of drain to sump[1]	(inches) Diameter of Vent (inches)										
	1¼	1½	2	2½	3	4	5	6	8	10	12
2	23	52	290								
2½	5	13	89	290							
3		2	30	110	290						
4			1	17	57	280					
5					10	80	280				
6						20	97	280			
8							3	41	270		
10								1	53	250	
12										61	230

Note 1: Where more than one drain connects to the sump, size vent on the basis of a drain diameter having a cross sectional area equal to the sum of the areas of the multiple drains.

Note 2: The above values provide for a maximum of 1 inch pressure drop in the system.

2.17: Storm Drains

(1) Storm Water Drainage to Sewer Prohibited. Storm water shall not be drained into sewers intended for sewage only.

(2) Size of Building Storm Drain. The size of the building storm drain or any of its horizontal branches having a slope of ½ inch or less per foot, shall be based upon the maximum projected roof or paved area to be handled according to Table 1 in 248 CMR 2.17, Size of Horizontal Storm Drains.

TABLE 1
SIZE OF HORIZONTAL STORM DRAINS[1]

	Maximum projected roof area for drains of various slopes		
Diameter of drain, inches	1/8 in. slope	1/4 in. slope	1/2 in. slope
	Square feet	Square feet	Square feet
3		1,160	1,644
4	1,880	2,650	3,760
5	3,340	4,720	6,680
6	5,350	7,550	10,700
8	11,500	16,300	23,000
10	20,700	29,200	41,400
12	33,300	47,000	66,600
15	59,500	84,000	119,000

Note 1: Table 1 is based upon a maximum rate of rainfall -- 4 inches per hour.

(a) Vertical Leaders. A vertical leader shall be based upon the maximum projected roof area to be drained according to the following Table 2 in 248 CMR 2.17.

TABLE 2
SIZE OF VERTICAL LEADERS

Maximum Projected Roof Area (square feet)	Diameter of Leaders (inches)	Maximum Projected Roof Area (square feet)	Diameter of Leaders (inches)
720	2	8,650	5
1,300	2½	13,500	6
2,200	3	29,000	8
4,600	4		

(3) Valves for Continuous Flow. Where there is a continuous or semicontinuous discharge into the building storm drain or building storm sewer, as from a pump, ejector, air conditioning plant, or similar device, each gallon per minute of such discharge shall be computed as being equivalent to 24 square feet of roof area, based upon a 4-inch rainfall.

(4) Building Sub-drains. Building sub-drains located inside the building below the public gravity sewer level shall discharge into a sump or receiving tank, the contents of which shall be automatically lifted and discharged into the drainage system as required for building sumps.

2.17: continued

(5) Sub-Soil Drains.

(a) When subsoil drain for building is subject to backwater, it shall be protected by an accessibly located backwater valve. Subsoil drains may discharge into a properly trapped area drain or sump. Such sumps do not require vents. Piping used for sub-soil drains shall not be less than 4 inches in diameter.

(b) Materials for sub-soil drains shall be vitrified clay fibre or asbestos cement pipe. Piping may be either perforated or installed with open joints. Spigot end lengths shall have joints protected with screens securely fastened to pipes. Screens and fastenings shall be non-ferrous or other approved corrosion resisting material. Perforated piping shall be installed with sealed joints. All sub-soil drain piping shall be installed with sufficient pea stone or similar aggregate to permit the flow of ground water to the piping.

(6) Traps on Storm Drains and Leaders.

(a) Where Required. Leaders and storm drains serving low roofs when connected to a combined sewer shall be trapped.

(b) Where Not Required. No traps shall be required for storm-water drains which are connected to a sewer carrying storm water exclusively.

(c) Trap Material. Storm water traps, when required, shall be of cast iron.

(d) Trap Size. Traps for individual conductors shall be the same size as the horizontal drain to which they are connected.

(e) Method of Installation. Individual storm-water traps shall be installed on the storm-water drain branch serving each conductor, or a single trap shall be installed in the main storm drain just before its connection with the combined building, sewer main, drain, or public sewer. Conductor traps shall be located so that an accessible cleanout may be installed on the building side of the trap.

(7) Conductors and Connections.

(a) Not to Be Used Improperly. Conductor pipes shall not be used as soil, waste, or vent pipes nor shall drainage or vent pipes be used as conductors.

(b) Protection of Rain Water Conductors. Rain water conductors installed along alley ways, driveways, or other locations where they may be exposed to damage shall be protected by metal guards or recessed into the wall.

(c) Combining Storm with Sanitary Drainage. The sanitary and storm drainage system of a building shall be entirely separate. Where a combined sewer is available, the building storm sewer may be connected to the building sanitary sewer in the same horizontal plane through a single wye fitting to form a combined building sewer at least 10 feet outside the inside face of the foundation wall.

(d) Offsets. Offsets of 45 degrees or less from the vertical, and offsets of more than 45 degrees from the vertical that do not exceed 10 feet in length, shall be sized according to Table 2 in 248 CMR 2.17. Offsets of more than 45 degrees from the vertical in excess of 10 feet shall be sized according to Table 1 in 248 CMR 2.17.

(8) Roof Drains.

(a) Material of Roof Drains. Roof drains shall be of cast iron, copper, or other approved corrosion-resisting material.

(b) Roof Drain Strainers.

1. General Use. All roof areas, except those draining to hanging gutters, shall be equipped with roof drains having strainers extending not less than 4 inches above the surface of the roof immediately adjacent to the roof drain. Strainers shall have an available inlet area, above roof level, of not less than 1½ times the area of the conductor or leader to which the drain is connected.

2.17: continued

2. Flat Decks. Roof drain strainers for use on sun decks, parking decks, and similar areas, normally serviced and maintained, may be of the flat surface type, level with the deck and shall have an available inlet area not less than 2 times the area of the conductor or leader to which the drain is connected.
3. Roof Drain Flashings Required. The connection between roofs and roof drains which pass into the interior of the building shall be made watertight by the use of proper flashing methods and material.

(9) Expansion Joints Required. Expansion joints or sleeves shall be provided where warranted by temperature variations or physical conditions.

(10) Sanitary and Storm Sewers. Where separate systems of sanitary drainage and storm water are installed in the same property, the storm and sanitary building sewers and drains may be laid side by side in the same trench.

2.18: Hospital Fixtures

(1) General. The plumbing system in a hospital shall conform not only to the criteria of this section but also to the requirements contained in the body of this code and with requirements of the Massachusetts Department of Environmental Quality Engineering.

(2) Definitions.

Aspirator. An aspirator is a fitting or device supplied with water or other fluid under positive pressure which passes through an integral orifice or "constriction" causing a vacuum. Aspirators are often referred to as "suction" apparatus, and are similar in operation to an ejector.

Autopsy Table. An autopsy table is a fixture or table used for the post-mortem examination of a body.

Bedpan Hopper (Clinic Sink). A bedpan hopper is a fixture meeting the design requirements of fixture, sometimes called a clinic sink.

Bedpan Steamer. A bedpan steamer is a fixture used for scalding bedpans or urinals by direct application of steam.

Bedpan Washer. A bedpan washer is a fixture designed to wash bedpans and to flush the contents into the soil drainage system. It may also be provided for steaming the utensils with steam or hot water.

Bedpan Washer Hose. A bedpan washer hose is a device supplied with hot and/or cold water and located adjacent to a water closet or clinic sink to be used for cleansing bedpans.

Clinic Sink. See Bedpan Hopper and 248 CMR 2.18(3)(b).

Flushing Type Floor Drain. A flushing type floor drain is a floor drain which is equipped with an integral water supply, enabling flushing of the drain receptor and trap.

Local Vent Stack. A local vent stack is a vertical pipe to which connections are made from the fixture side of traps and through which vapor and/or foul air may be removed from the fixture or device used on bedpan washers.

2.18: continued

Sterilizer, Boiling Type. A boiling type "sterilizer" is a fixture (non-pressure type) used for boiling instruments, utensils, and/or other equipment (used for disinfection). Some devices are portable, others are connected to the plumbing system.

Sterilizer Instrument. See Sterilizer, Boiling Type.

Sterilizer, Pressure Instrument Washer-Sterilizer. A pressure instrument washer-sterilizer is a fixture (pressure vessel) designed to both wash and sterilize instruments during the operating cycle of the fixture.

Sterilizer, Pressure (Autoclave). A pressure sterilizer is a fixture (pressure vessel) designed to use steam under pressure for sterilizing. Also called an Autoclave.

Sterilizer, Utensil. See Sterilizer, Boiling Type.

Sterilizer Vent. A sterilizer vent is a separate pipe or stack, indirectly connected to the building drainage sytem at the lower terminal, which receives the vapors from nonpressure sterilizers, or the exhaust vapors from pressure sterilizers, and conducts the vapors directly to the outer air, sometimes called vapor, steam, atmospheric or exhaust vent.

Sterilizer Water. A water sterilizer is a device for sterilizing water and storing sterile water.

Still. A still is a device used in distilling liquids.

(3) Fixtures.
(a) General. Acceptable flush rim bedpan hoppers (clinic sinks), bedpan washers, and/or other acceptable fixtures and equipment shall be provided for the disposing of bedpan contents and the cleansing and disinfection of bedpans in soiled utility (hopper) rooms.
(b) Clinic Sink. A clinic sink shall have an integral trap in which the upper portion of a visible trap seal provides a water surface. The fixture shall be so designed as to permit complete removal of the contents by siphonic and/or blowout action, and to reseal the trap. A flushing rim shall provide water to cleanse the interior surface. The fixtures shall have flushing and cleansing characteristics similar to a water closet.
(c) Prohibited Use of Clinic Sinks and Service Sinks. A clinic sink serving a soiled utility room shall not be considered as a substitute for, nor shall it be used as a janitor's service sink. A janitor's service sink shall not be used for the disposal of urine, fecal matter, or other human wastes.
(d) Ice Prohibited in Soiled Utility Rooms. No machine for manufacturing ice, or any device for the handling or storage of ice shall be located in a soiled utility room. Machines for manufacturing ice, or devices for handling or storage of ice intended for either human consumption or packs, may be located in clean utility room, floor pantry, or diet kitchen.

(4) Sterilizer Equipment Requirements.
(a) Descaling of Equipment Prohibited. It shall be unlawful to descale or otherwise submit the interior of water sterilizers, stills, or similar equipment to acid or other chemical solutions while the equipment is connected to the water and/or drainage system.
(b) ASME Standard. New pressure sterilizers and pressure instruments washer-sterilizers hereafter installed, shall display in a location to be clearly visible at all times, the ASME Standard symbol and data plate.

2.18: continued

(c) Sterilizer Piping. All sterilizer piping and/or devices necessary for the operation of sterilizers shall be accessible for inspection and maintenance.

(d) Condensers. Pressure sterilizers shall be equipped with an acceptable means of condensing and cooling the exhaust steam vapors.

Nonpressure sterilizers should be equipped with an acceptable device which shall automatically control the vapors in a manner to confine them within the vessel, or equipped with an acceptable means of condensing and cooling of vapors.

(e) Gas Fired Equipment. Gas fired equipment or apparatus shall be installed in accordance with the requirements of the Massachusetts Gas Code.

(5) Special Elevations. Control valves, vacuum outlets, and devices which protrude from a wall of an operating, emergency, recovery, examining, or delivery room, or a corridor and/or other locations where patients may be transported on a wheeled stretcher, shall be so located at an elevation which will preclude bumping the patient or stretcher against the device. When necessary to install at a lower elevation, safety precautions should be taken to protect the personnel.

(6) Plumbing in Mental Hospitals. In mental hospitals, special consideration should be given to piping, controls, and fittings of plumbing fixtures as required by the types of mental patients being treated. No pipes or traps shall be exposed and fixtures shall be substantially bolted through walls.

(7) Drainage and Venting.

(a) Ice Storage Chest Drains. Any drain serving an ice chest or box shall discharge over an indirect waste receptor separate from all other fixture wastes. Each terminal shall discharge through an air gap above the receptor. The end shall be covered with a removable screen of not less than ten mesh per inch, and if discharging vertically, the terminal shall be cut at an angle of 45 degrees.

(b) Bedpan Washers and Clinic Sinks. Bedpan washers and clinic sinks shall be connected to the soil pipe system and vented following the requirements as applied to water closets except that bedpan washers require additional local vents.

(8) Sterilizer Wastes.

(a) Indirect Wastes Required. All sterilizers shall be provided with individual and separate indirect wastes, with air gaps of not less than two (2) diameters of the waste tailpiece. The upper rim of the receptor, funnel, or basket type waste fitting shall be not less than two inches (2") below the vessel or piping, whichever is lower.

Except as provided in 248 CMR 2.18(8)(c) and 2.18(8)(e) a "P" trap shall be installed on the discharge side of, and immediately below, the indirect waste connection serving each sterilizer.

(b) Floor Drain Required. In all recess rooms containing the recessed, or concealed portions of sterilizers, not less than one acceptable floor drain, connecting to the drainage system, shall be installed in a manner to drain the entire floor area.

(c) Recess Room Floor Drains, Trap Seal Maintenance. The recess room floor drain waste and trap shall be a minimum diameter of 3 inches. It shall receive the drainage from at least one sterilizer within the recess room to assure maintenance of the floor drain trap seal. The sterilizer drain shall be installed on a branch taken off between the floor drain trap and the drain head. No individual sterilizer waste trap shall be required on this type of installation.

(d) Prohibited Connections. Branch funnel and branch basket

2.18: continued

type fittings, except as provided in 248 CMR 2.18(8)(e) are prohibited on any new installation or when relocating existing equipment. Existing branch funnel or branch basket type installations shall be provided with an acceptable indirect waste below the branch connections.

(e) Battery Assemblies. A battery assembly of not more than three sterilizer wastes may drain to one trap, provided the trap and waste are sized according to the combined fixture unit rating; the trap is located immediately below one of the indirect waste connections; the developed distance of a branch does not exceed 8 feet; and the branches change direction through a tee-wye or wye pattern fitting.

(f) Bedpan Steamers, Additional Trap Required. A trap with a minimum seal of 3 inches shall be provided in a bedpan steamer drain located between the fixture and the indirect waste connection.

(g) Pressure Sterilizer. Except when an exhaust condenser is used a pressure sterilizer chamber drain may be connected to the exhaust drip tube before terminating at the indirect waste connection. If a vapor trap is used, it shall be designed and installed to prevent moisture being aspirated into the sterilizer chamber. The jacket steam condensate return, if not connected to a gravity steam condensate return, shall be separately and indirectly wasted. If necessary to cool a high temperature discharge, a cooling receiver, trapped on its discharge side, may serve as the fixture trap.

(h) Pressure Sterilizer Exhaust Condensers. The drain from the condenser shall be installed with an indirect waste as prescribed in the Code. If condensers are used on pressure sterilizers, the chamber drain shall have a separate indirect waste connection.

(i) Water Sterilizer. All water sterilizer drains, including tank, valve leakage, condenser, filter and cooling, shall be installed with indirect waste or according to 248 CMR 2.18(8)(b).

(j) Pressure Instrument Washer-Sterilizer. The pressure instrument washer-sterilizer chamber drain and overflow may be interconnected. Also, they may be interconnected with the condenser. The indirect waste shall follow the provision set forth in the Code.

(k) Aspirators. In operating rooms, emergency rooms, recovery rooms, delivery rooms, examining rooms, autopsy rooms, and other locations except laboratories where aspirators are installed for removing blood, pus and/or other fluids, the discharge from any aspirator shall be indirectly connected to the drainage system. The suction line shall be provided with a bottle or similar trap to protect the water supply.

(9) Central Vacuum and/or Disposal Systems.

(a) Wastes. The waste from a central vacuum (fluid suction) system of the disposal type and/or which is connected to the drainage system whether the disposal be by barometric leg, collecting tanks, or bottles, shall be directly connected to the sanitary drainage system through a trapped waste.

(b) Piping. The piping of a central vacuum (fluid suction) system shall be of corrosion resistant material having a smooth interior surface. No branch shall be less than ½ inch for one outlet and sized according to the number of vacuum outlets, and no main shall be less than 1 inch. The pipe sizing shall be increased according to the manufacturer's recommendation as stations are increased. All piping shall be provided with adequate and accessible clean-out facilities on mains and branches, and shall be accessible for inspection, maintenance, and replacements.

(c) Water Systems for Space Cooling and Heating Condensate Drains. The lowest point of a condensate riser or risers shall be trapped and discharged over an indirect waste sink. The trap may be either "P" or a "running trap" with a cleanout. A branch shall be installed upstream from the condensate drain trap for flushing

2.18: continued

and resealing purposes. The condensate drain and trap shall be located above the lowest floor level of the building.

(10) Vent Material. Material for local vents serving bedpan washers and sterilizer vents serving sterilizers, shall be sufficiently rust proof, erosion and corrosion resistant to withstand intermittent wetting and drying from steam vapors, to withstand the distilled water solvent action of the steam vapors and to withstand frequent and immediate changes of temperatures.

(11) Vent Connections Prohibited. Connections between local vents serving bedpan washers, sterilizer vents serving sterilizing apparatus, and/or normal sanitary plumbing systems, are prohibited. Furthermore, only one type of apparatus shall be served by a given vent.

(12) Local Vents and Stacks.
(a) Bedpan Washers. Bedpan washers shall be vented to the outer atmosphere above the roof by means of one or more local vents. The local vent for a bedpan washer shall be not less than a 2-inch diameter pipe. A local vent serving a single bedpan washer may drain to the fixture served.

(13) Multiple Installations. Where bedpan washers are located above each other on more than one floor, a local vent stack may be installed to receive the local vent on the various floors. Not more than 3 bedpan washers shall be connected to a 2-inch local vent stack, 6 to a 3-inch local vent stack, and 12 to a 4-inch local vent stack. In multiple installations, the connections between a bedpan washer local vent and local vent stack shall be made by use of the tee or tee-wye sanitary pattern drainage fittings, installed in an upright position.

Trap Required. The bottom of the local vent stack, except when serving only one bedpan washer, shall be drained by means of a trapped and vented waste connection to the plumbing sanitary drainage system. The trap and waste shall be the same size as the local vent stack.

(14) Trap Seal Maintenance. A water supply of not less than one-quarter inch minimum tubing shall be taken from the flush supply of each bedpan washer on the discharge or fixture side of the vacuum breaker, trapped to form not less than a 3-inch seal, and connected to the local vent stack on each floor. The water supply shall be so installed as to provide a supply of water to the local vent stack for cleansing and drain trap seal maintenance each time a bedpan washer is flushed.

(15) Sterilizer, Vents and Stacks.
(a) Connections. Multiple installations of pressure and nonpressure sterilizers shall have their vent connections to the sterilizer vent stack made by means of inverted wye fittings. Such vent connections shall be accessible for inspection and maintenance.
(b) Drainage. The connection between the sterilizer vent stack shall be designed and installed to drain to the funnel or basket-type waste fitting. In multiple installations, the sterilizer vent stack shall be drained separately to the lowest sterilizer funnel or basket-type waste fitting or receptor.

(16) Sterilizer Vent Stack Sizes.
(a) Bedpan Steamers. The minimum size of a sterilizer vent serving a bedpan steamer shall be one and one-half inches in diameter. Multiple installations shall be sized according to Table 1 in 248 CMR 2.18, Stack Sizes for Bedpan Steamers and Boiling Type Sterilizers, (number of connections of various sizes sterilizer vent stacks).

2.18: continued

TABLE 1
STACK SIZES FOR BEDPAN STEAMERS
AND BOILING TYPE STERILIZERS

Stack Size	Connection Size	
	1½"	2"
1½ inch[1]	1 or	0
2 inch[1]	2 or	1
2 inch[2]	1 and	1
3 inch[1]	4 or	2
3 inch[2]	2 and	2
4 inch[1]	8 or	4
4 inch[2]	4 and	4

Note 1: Total of each size
Note 2: Combination of sizes

(b) Boiling Type Sterilizers. The minimum size of a sterilizer vent stack shall be 2 inches in diameter when serving a utensil sterilizer, and 1½ inches in diameter when serving an instrument sterilizer. Combinations of building type sterilizer vent connections shall be based on Table 1 in 248 CMR 2.18, Stack Sizes for Bedpan Steamers and Boiling Type Sterilizers.

(c) Pressure Sterilizers. Sterilizer vent stacks shall be two and one-half inches minimum; those serving combinations of pressure sterilizer exhaust connections shall be sized according to Table 2 in 248 CMR 2.18, Stack Sizes for Pressure Sterilizers.

(d) Pressure Instrument Washer-Sterilizer Sizes. The minimum size of a sterilizer vent stack serving an instrument washer-sterilizer, shall be 2 inches in diameter. Not more than two sterilizers shall be installed on a 2-inch stack, and not more than four on a 3-inch stack.

TABLE 2

STACK SIZES FOR PRESSURE STERILIZERS

Number of Connections of Various Sizes Permitted
to Various Size Vent Stacks

Stack Size	Connection Size						
	3/4"		1"		1¼"		1½"
1½ inch[1]	3	or	2	or	1		
1½ inch[2]	2	and	1				
2 inch[1]	6	or	3	or	2	or	1
2 inch[2]	3	and	2				
2 inch[2]	2	and	1	and	1		
2 inch[2]	1	and	1	and			1
3 inch[1]	15	or	7	or	5	or	3
3 inch[2]			1	and	2	and	2
3 inch[2]	1	and	5	and			1

Note 1: Combination of sizes
Note 2: Total of each size

(17) Radioactive Materials. All radioactive materials shall be disposed of in a manner so as to create no hazard to operation and maintenance personnel of the institution or to the public. Specific permission shall

2.18: continued

be secured from the State Department of Public Health to dispose of any radioactive material to the drainage system.

(18) Water Supply.

(a) Water Service. All hospitals shall have dual services installed in a manner to provide an uninterrupted supply of water in case of a water main break.

(b) Hot Water Heater and Tanks. The hot water equipment shall have sufficient capacity to supply water at 125°F. for hospital fixtures; water at 180°F. for kitchens; and water at 180°F. for laundry. Where direct fired hot water heaters are used, they shall be of an approved high pressure type. Submerged steam heating coils should be of copper. Storage tanks shall be fabricated of noncorrosive metal or be lined with noncorrosive material.

(c) Hot Water Supply System. Hot water circulating mains and risers should be run from the hot water storage tank to a point directly below the highest fixture at the end of each branch main. Where the building is higher than three stories, each riser shall be circulated. Each main, branch main, riser and branch to a group of fixtures of the water system shall be valved.

(19) Vacuum Breaker Installation.

(a) Hose Connections. For ordinary hose connections the maximum height at which any hose is to be used shall be treated at its flood level.

(b) Low Volume Flows. Where low volume flows might cause leaking or spitting at the vacuum breaker parts, back pressure may be developed by installing an acceptable minimum orifice valve on the discharge side of the vacuum breaker. This shall be in addition to the regular control valve. This type of installation shall be subject to review and acceptance by the Inspector of Plumbing before installation.

(c) Prohibited Water Closet and Clinic Sink Supply. No jet or water supplied orifices, except those supplied by the flush connection, shall be located in and/or connected with a water closet bowl or clinic sink. This section shall not prohibit an acceptable bidet installation.

(d) Special Equipment, Water Supply Protection. The Table 3 in 248 CMR 2.18, Hospital Fixtures and Their Water Supply Protection, sets forth the requirements which shall be followed in protecting the water supply for hospital fixtures against backflow or backsiphonage.

2.18: continued

TABLE 3
HOSPITAL FIXTURES AND THEIR WATER SUPPLY PROTECTION

Fixtures	Type of Protection[1]	Remarks
Aspirators:		
Laboratory	Vacuum breaker	
Portable	Vacuum breaker	
Vacuum system	Vacuum breaker	
Bedpan:		
Washers	Vacuum breaker	
Washer hose	Vacuum breaker	Locate 5 feet above floor.
Boiling type sterilizer	Air gap	Not less than twice the effective opening of the water supply.
Exhaust condenser	Vacuum breaker	
Flush floor drain	Vacuum breaker	
Hose connection	Vacuum breaker	Locate 6 feet above floor.
Pressure instrument washer-sterilizer	Vacuum breaker	
Pressure sterilizer	Vacuum breaker	
(rubber Tube Testers-Washers)	Vacuum breaker	
Vacuum systems:		
Cleaning	Air gap or vacuum breaker	
Fluid suction	Air gap or vacuum breaker	

Note 1: Where vacuum breakers are used, they shall be installed after the last control valve.

2.18: continued

(20) Clinical, Hydrotherapeutic and Radiological Equipment. All clinical, hydrotherapeutic, radiological, or any equipment, whether mentioned or not, which is water supplied and/or discharges to the waste system, shall meet the requirements of this Section and the Code covering cross-connections, air gaps, vacuum breakers, and check valves.

(a) Special Equipment and Devices Found Under These Classes Include:

Clinical	Hydrotherapeutic	Radiological	Other
Dental cuspidors	Control units	Violet X-ray	
Surgical cuspidors	Arm bath	Diagnostic X-ray	
Dental (flush rim) lavatories	Leg bath	Therapy X-ray	
Colonic irrigation	Foot bath	X-ray target	
Sitz bath	Tub bath	X-ray transformers	
Emergency bath	Immersion bath	X-ray oil tank	
Receiving bath	Shower bath	Diffraction	
Prenatal bath	Needle bath		
Infant bath	Tank	X-ray developing	
Prophylaxis	Pool	Photographic developing	
Shampoo	Hose	Film developing	
Massage	Syringe	Microscopic	
	Douche		

(21) Condensate Drain Trap Seal. A water supply shall be provided for cleaning, flushing, and resealing the condensate trap. The source of the water supply shall be a refrigerator condenser discharge, a drinking fountain waste, or other acceptable method of flushing and resealing the trap. The water supply shall be not less than 1/2 inch diameter pipe, and shall discharge through an air gap not less than twice the diameter of the supply pipe.

(22) Valve Leakage Diverter. Each water sterilizer which may be filled with water through directly connected piping, shall be equipped with an acceptable leakage diverter and/or bleed-line on the water supply control valve to indicate and conduct any leakage of unsterile water away from the sterile zone.

2.19: Plumbing in Mobile Homes

(1) Definitions.

(a) Mobile Home. Mobile Home means a structure, transportable in one or more sections which when erected on site measures eight body feet or more in width and thirty-two body feet or more in length, built on a permanent chassis and designed to be used as a dwelling, with or without a permanent foundation, when connected to the required utilities and includes the plumbing, heating, air conditioning and electrical systems contained therein.

(b) Label. Label means the adhesive-back aluminum foil decal which is permanently affixed to each transportable section of each Mobile Home manufactured for sale in the United States and which serves as the certification by the manufacturer of conformance with the rules made under the Federal Mobile Home Construction and Safety Standard. In effect on the date of manufacture.

(2) Scope. Plumbing in Mobile Homes shall comply to the latest Rules and Regulations established by the Secretary of the Department of

2.19: continued

Housing and Urban Development authorized by the National Mobile Home Construction and Safety Act of 1974.

Such rules are to be effective as of June 15, 1976.

"These rules and regulations supersede all State Plumbing and/or Gas Codes."

Additions or renovations made to the Plumbing and/or Gas Systems of such units shall be made in compliance with all provisions of Chapter 142 of the General Laws and the Massachusetts State Plumbing and Gas Codes.

2.20: Swimming Pools

(1) General. All swimming pools must be installed in full compliance with all provisions of Title V of the Environmental Code of the Massachusetts Department of Environmental Quality Enginnering (310 CMR 15.00).

The issuing of permits, payment of fees, inspection, approval and installation of all swimming pools must also conform to all provisions of the Massachusetts State Plumbing Code.

(2) Definitions.

(a) Swimming Pool means and includes every artificial pool of water having a depth of two feet or more at any point and used for swimming or bathing, located indoors or outdoors, together with the bathhouses, equipment, and appurtenances used in connection with the pool. It does not include any residential pool as herein defined nor does it include any pool used primarily for baptismal purposes or the healing arts.

(b) Public Pool means every swimming or wading pool admission to which may be gained by the general public with or without the payment of a fee.

(c) Semi-Public pool means a swimming or wading pool on the premises of, or used in connection with a hotel, motel, trailer court, apartment house, country club, youth club school, camp, or similar establishment where the primary purpose of the establishment is not the operation of the swimming facilities, and where admission to the use of the pool is included in the fee or consideration paid or given for the primary use of the premises. Semi-public pool shall also mean a pool constructed and maintained by groups for the purposes of providing bathing facilities for members and guests only.

(d) Residential Pool means a swimming or wading pool established or maintained by an individual for his own or family's use or for the use of personal guests of his household.

(e) Wading Pool means a pool of water in a basin having a maximum depth of less than two feet intended chiefly as a wading place for children. It does not include any residential pool as herein defined.

(f) Operator means any person who

1. alone or jointly or severally with others owns a public or semi-public swimming pool or wading pool regulated by this article, or
2. has case, charge or control of such a pool as agent or lessee of the owner or as an independent contractor.

(g) Person means every individual, partnership, corporation, firm, association or group, including a city, town, county, or other governmental unit.

(h) Board of Health means the appropriate and legally designated health authority of the city, town or other legally constituted governmental unit within the Commonwealth having the usual powers and duties of the board of health of a city or town, or his or its authorized agent or representative.

2.20: continued

(3) Plan Approval. No person shall construct or install a swimming or wading pool or expand, remodel, or otherwise make any change which may affect the compliance of an existing swimming or wading pool with the requirements of this code until the plans and specifications for the construction or change have been approved in writing by the Board of Health. Application for such approval shall be made on a form prescribed by, and containing such information as may be required by the Commissioner of the Massachusetts Department of Environmental Quality Engineering. Nothing in this regulation shall affect the authority of any person acting under appropriate sections of an applicable building, plumbing or electrical code, ordinance or regulation.

(4) Conformance. All work shall conform to approved plans and specifications. Any revision or change in the approved plans and specifications which may affect the capacity or the health or safety features of the swimming or wading pool shall be submitted to the board of health for review. Approval of said change or revision of plans shall be obtained in writing before the work affected by the change is undertaken.

(5) Notification. The Board of Health shall be notified when a newly constructed, expanded, or remodeled swimming or wading pool is ready for use. Notification shall be given at least one week prior to the completion of the project so that a date can be arranged for a final inspection. Use of such pool shall not commence before a final inspection has been made and approval, in writing, to operate has been given by the board of health.

(6) Prohibited Connections. Under no circumstances should piping systems be so designed and constructed as to permit pool water to enter a potable-water-supply system nor waste water or sewage to enter the pool through backflow connections or interconnections.

Cross-connections or interconnections in the pool piping system whereby pool water may under some conditions enter a potable-water-supply system should be avoided

(a) by providing for the admission of make-up water above the overflow elevation of the pool or by pumping from a pump suction well;

(b) where filters are installed and filter washing with the recirculation pump is not feasible, a washwater pump of proper capacity should be installed and a suction well or small elevated tank used to supply water to the pump, the discharge to the suction well or tank being above the flow line. In no case should valved cross-connections, whereby water from a potable-water-supply may be admitted directly to the recirculation system for the purpose of filter washing, be permitted. No pool drains or drains from filters, where the recirculating system is used, should be directly connected to sewers. Such drains should discharge by an indirect connection to a properly trapped sump. Where such indirect connections are not possible, pumping of pool and filter-wash drainage may be necessary.

2.21: Boiler Blow-Off Tank

(1) Boiler Blow-Off Tank (See detail sketch, Figure 1 in 248 CMR 2.22). A vessel designed to receive the discharge from a boiler blow-off outlet and to cool the discharge to a temperature of 150 degrees or less which permits its safe discharge to the drainage system.

(a) Shall be in full accordance with the recommendations of the National Board of Boiler and Pressure Vessel Inspectors for Boiler Blow-off Equipment, Columbus, Ohio.

2.21: continued

(b) The temperature of water entering drainage piping from discharge of blow-off equipment shall not exceed 150°F.
(c) The pressure of the blow-down leaving any type of blow-off equipment shall not exceed 5 p.s.i.g.
(d) The blow-off piping and fittings between the boiler and the blow-off tank shall comply with Paragraph P-307 to 312 inclusive of the ASME Power Boiler Code.
(e) All materials used in the fabrication of boiler blow-off equipment shall comply with material Section II of the ASME Boiler Code.
(f) All blow-off equipment shall be fitted with openings to facilitate cleaning and inspection.
(g) The blow-off tank shall be designed in accordance with Section VIII of the ASME Boiler Construction Code, for a working pressure of at least one fourth of maximum working pressure of the boiler to which it is connected. In no case, however, shall the plate thickness be less than 3/8".

(2) Direct Connections of Steam Exhaust, Blow-Offs and Drip Pipes.
(a) A steam exhaust, blow-off, or drip pipe shall not be directly connected to a building drainage system but shall first pass through a blow-off tank as shown in Blow-off Tank Sketch in this Code. Such waste water when it is discharged into a building drainage system shall have a temperature of not more than one hundred and fifty degrees Fahrenheit.
(b) Steam condensate which is to be discharged to the drainage system shall be provided with automatic cooling facilities to reduce the temperature of the water to a maximum temperature of 130 degrees F. These facilities shall include storage so that heat may be dissipated and cooling water when required shall be added by use of a thermostatically controlled device and only that portion of condensate about to be discharged to the drainage system shall be cooled.

The above applies particularly to systems of steam supply in which the steam condensate is discharged to waste rather than being returned to the steam generating plant such as steam supplied from street mains or from remote central steam generating plants.

2.22: Chapter 142

(1) Definitions. In this chapter the following words shall have the following meanings:

Certificate. A certificate of registration issued in accordance with section three of chapter five hundred and thirty-six of the acts of nineteen hundred and nine, section two of chapter five hundred and ninety-seven of the acts of nineteen hundred and ten or chapter five hundred and eighteen of the acts of nineteen hundred and twelve. "Examiners," the board of state examiners of plumbers and gas fitters appointed under section thirty-six of chapter thirteen.

Certificate of a plumbing corporation or certificate of a plumbing partnership. A certificate of registration issued to a master plumber authorizing him to conduct the plumbing business as a corporation or as a partner in a partnership, as the case may be.

Journeyman. A person who himself does any work in plumbing subject to inspection under any law, ordinance, by-law, rule or regulation.

Master Plumber. A plumber having a regular place of business and who, by himself or journeymen plumbers in his employ, performs plumbing work.

Apprentice. A person who is learning and working at the business of

2.22: continued

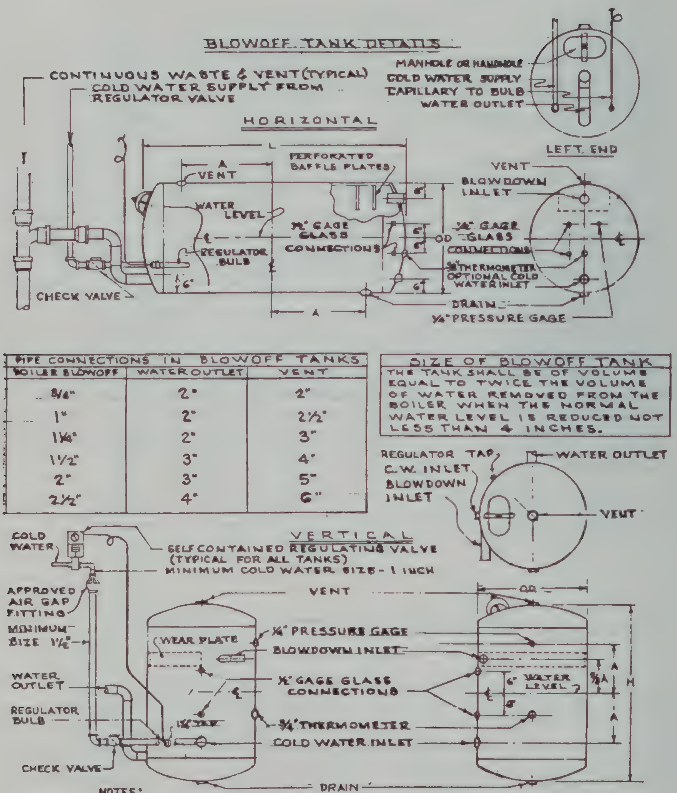
plumbing under the direct supervision of a master plumber or a journeyman.

Registered. Registered in accordance with section three of chapter five hundred and thirty-six of the acts of nineteen hundred and nine, section two of chapter five hundred and ninety-seven of the acts of nineteen hundred and ten or chapter five hundred and eighteen of the acts of nineteen hundred twelve.

(2) Board of State Examiners of Plumbers and Gas Fitters. There shall be a board of State Examiners of plumbers and gas fitters, in sections thirty-seven and thirty-eight called the examiners, consisting of nine members, citizens of the Commonwealth, of whom one shall have had at least ten years practical experience as a master plumber, one shall be a journeyman plumber with at least ten years practical experience, who is a wage earner, one shall be a sanitary engineer, one shall be a master gas fitter with at least ten years practical experience in the field of undiluted liquefied petroleum gas and natural gas, one shall be a journeyman gas fitter with at least ten years practical experience, who is a wage earner, one shall be a master or journeyman gas fitter with at least ten years practical experience in the design and installation of liquefied petroleum gas systems, one shall be the commissioner of public health or his designee, one shall be the commissioner of public safety or his designee, one shall be a representative of the public, subject to the provisions of section nine B. As the term of office of a member expires, his successor shall be appointed by the governor to serve for three years. The governor shall designate the chairman of the board and may at any time change such designation. The governor shall designate the appointee as the master plumber, the journeyman plumber, the master gas fitter, the journeyman gas fitter, the gas fitter competent in liquefied petroleum gas systems, the sanitary engineer or the public member of the board.

2.23: FIGURES

FIGURE 1



PIPE CONNECTIONS IN BLOWOFF TANKS		
BOILER BLOWOFF	WATER OUTLET	VENT
¾"	2"	2"
1"	2"	2½"
1¼"	2"	3"
1½"	3"	4"
2"	3"	5"
2½"	4"	6"

SIZE OF BLOWOFF TANK

THE TANK SHALL BE OF VOLUME EQUAL TO TWICE THE VOLUME OF WATER REMOVED FROM THE BOILER WHEN THE NORMAL WATER LEVEL IS REDUCED NOT LESS THAN 4 INCHES.

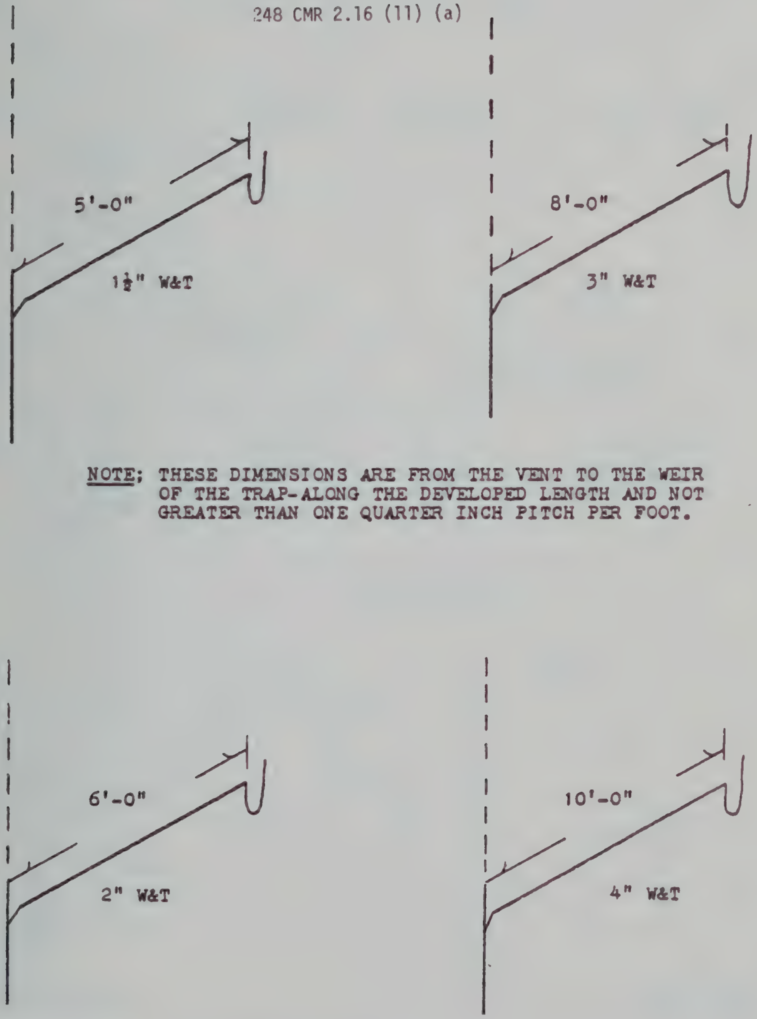
NOTES:

1 - DRAIN SIZE = 2" IN 36" DIA. OR LESS - 3" IN OVER 36" DIA.
2 - ALL TANKS SHALL BE SUPPLIED WITH APPROVED SUPPORTS.
3 - CONNECTIONS 4" I.P.S. AND LARGER SHALL BE FLANGED.
4 - 11"X15" MANHOLE IN 36" DIA. AND LARGER - 4"X6" HANDHOLE IN SMALLER DIA.
5 - DIMENSIONS "A" DETERMINED BY O.D. & LENGTH - MUST BE APPROVED.
6 - DRAWING NOT TO SCALE.

2.23: continued

FIGURE 2

248 CMR 2.16 (11) (a)

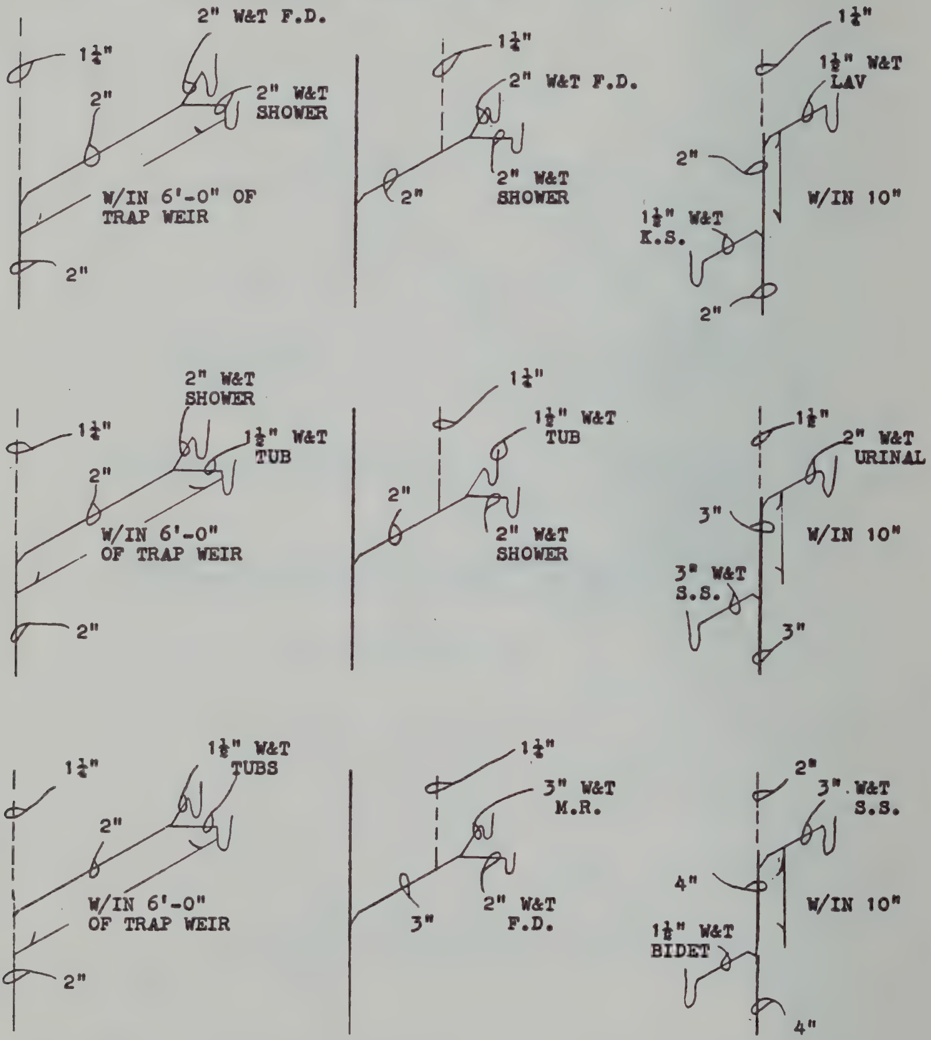


NOTE; THESE DIMENSIONS ARE FROM THE VENT TO THE WEIR OF THE TRAP-ALONG THE DEVELOPED LENGTH AND NOT GREATER THAN ONE QUARTER INCH PITCH PER FOOT.

2.23: continued

FIGURE 3

MISCELLANEOUS COMMON VENTING 248 CMR 2.16 (9)



HORIZONTAL WASTE BRANCH

248 CMR 2.16 (9) (e)

SIDE BY SIDE

248 CMR 2.16 (9) (b)

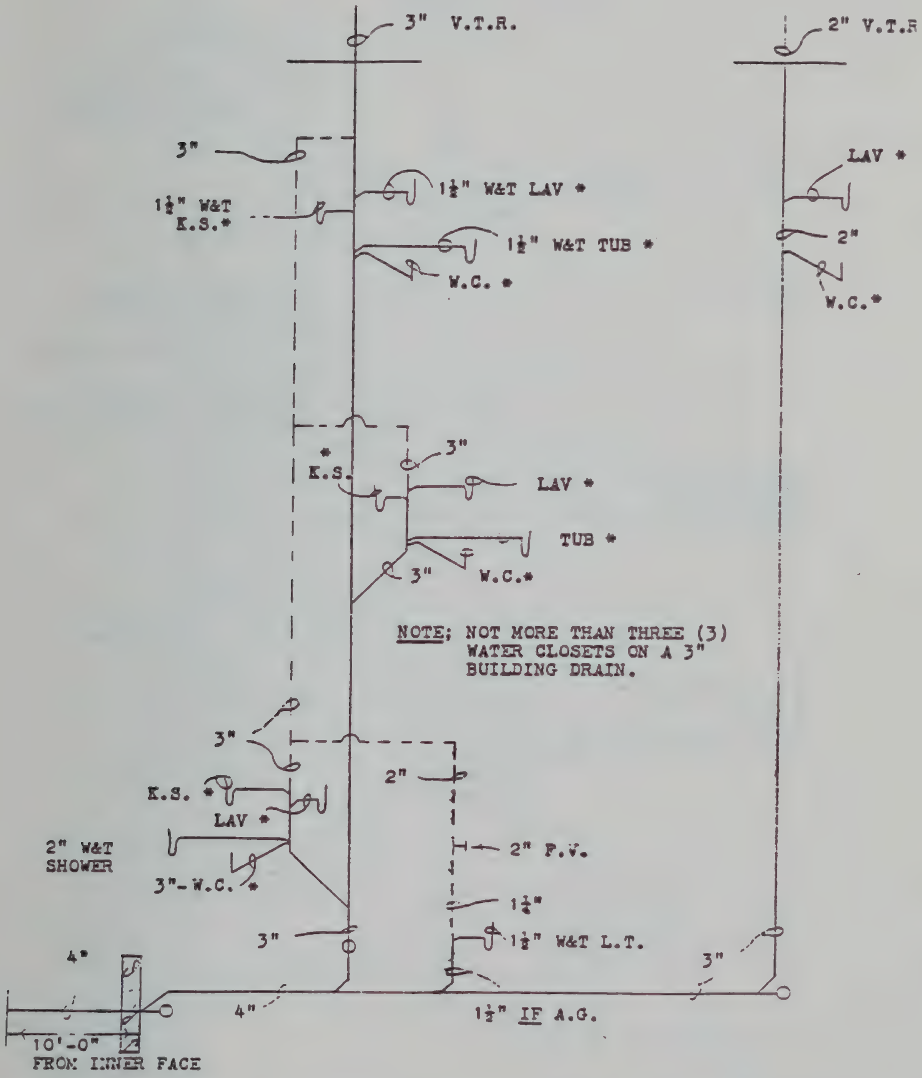
DIFFERENT LEVELS

248 CMR 2.16 (9) (c)

2.23: continued

FIGURE 4

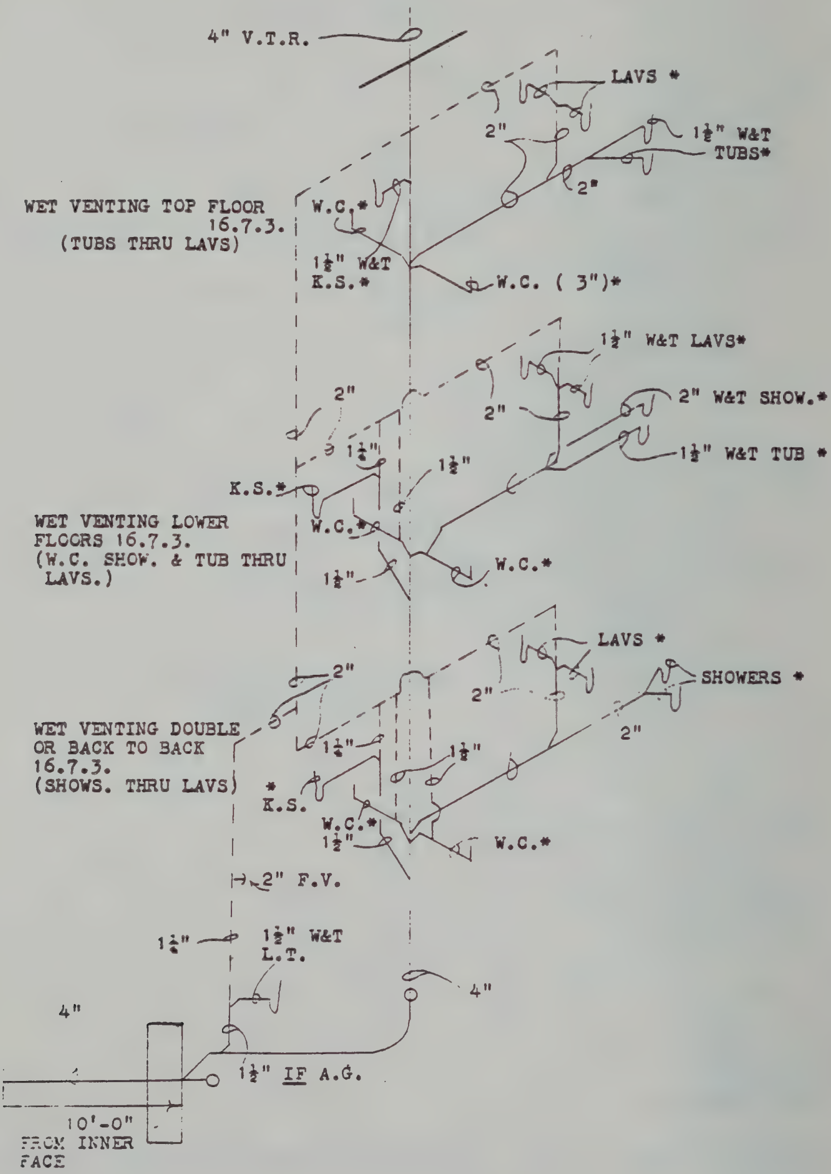
STACK VENTING
248 CMR 2.16(8)(a) and (b)



Include a bathtub or shower stall and a kitchen sink in the stack, on the extreme right hand side of the sketch. Such additional fixtures to be installed in accordance with 248 CMR 2.16(8)(a).

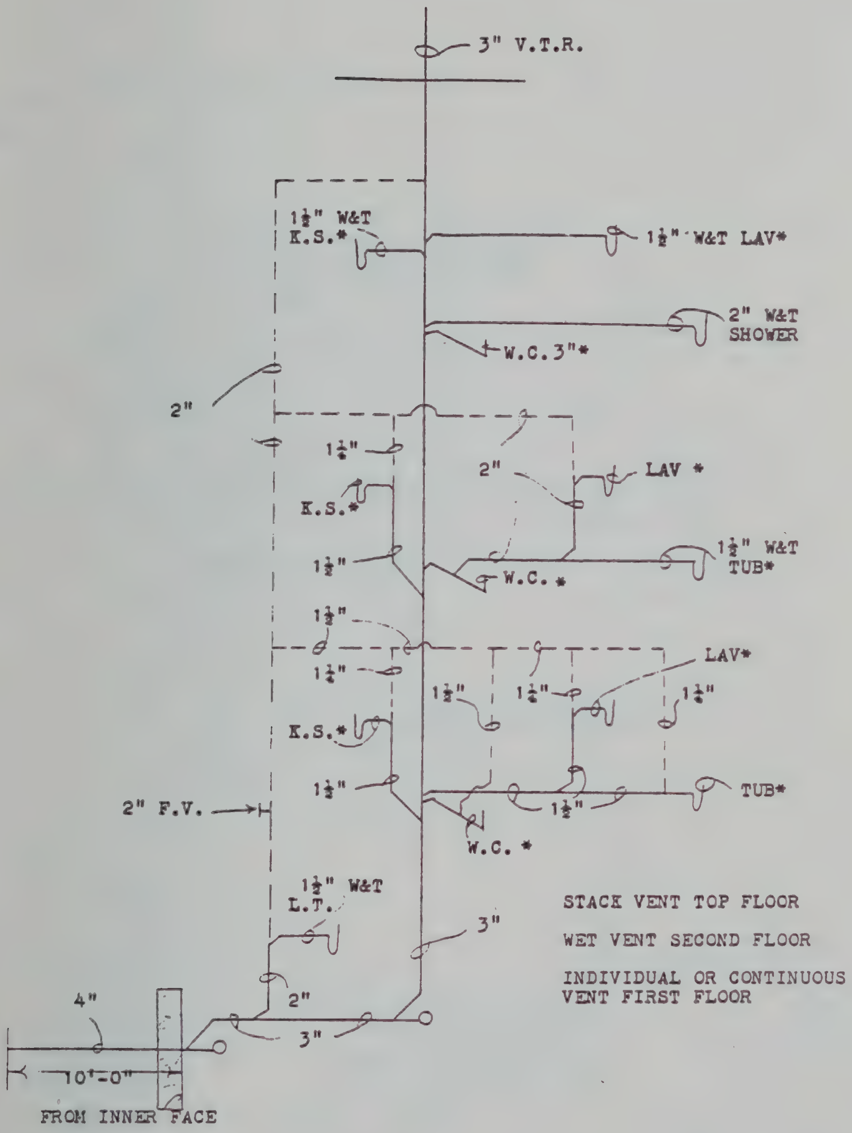
2.23:   continued

FIGURE 5



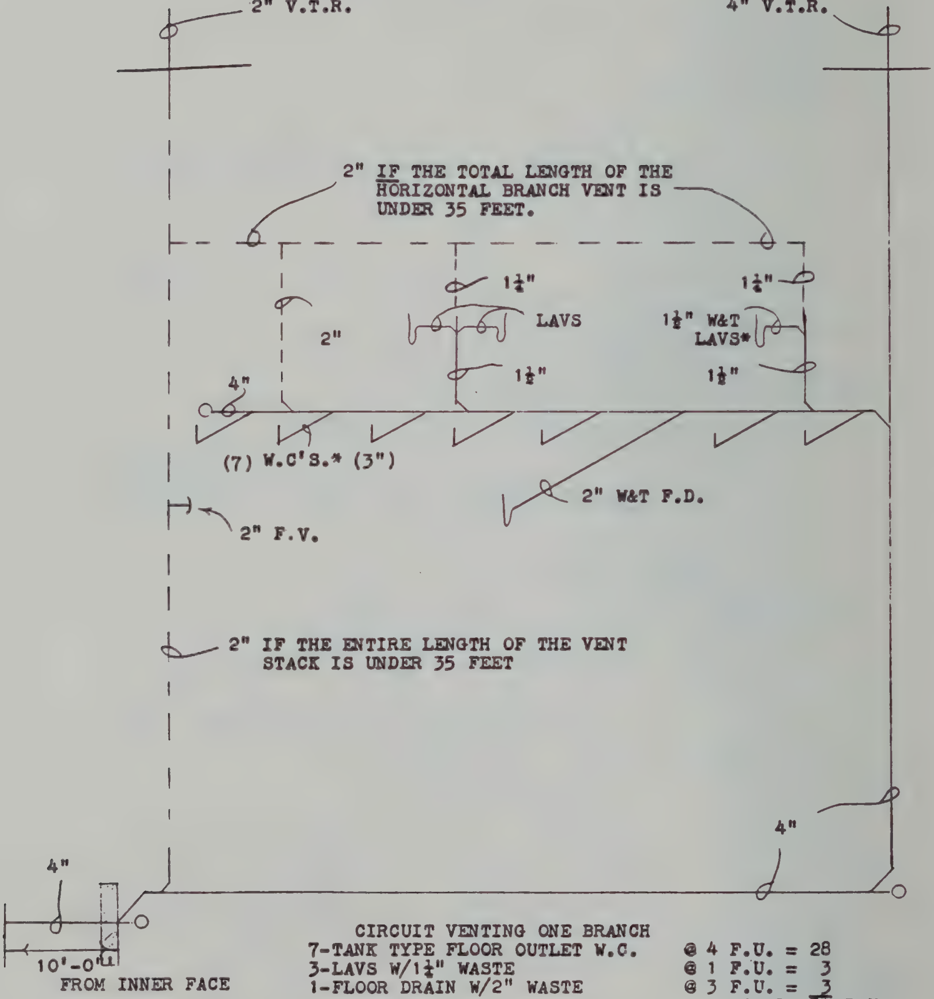
2.23: continued

FIGURE 6



2.23: continued

FIGURE 7

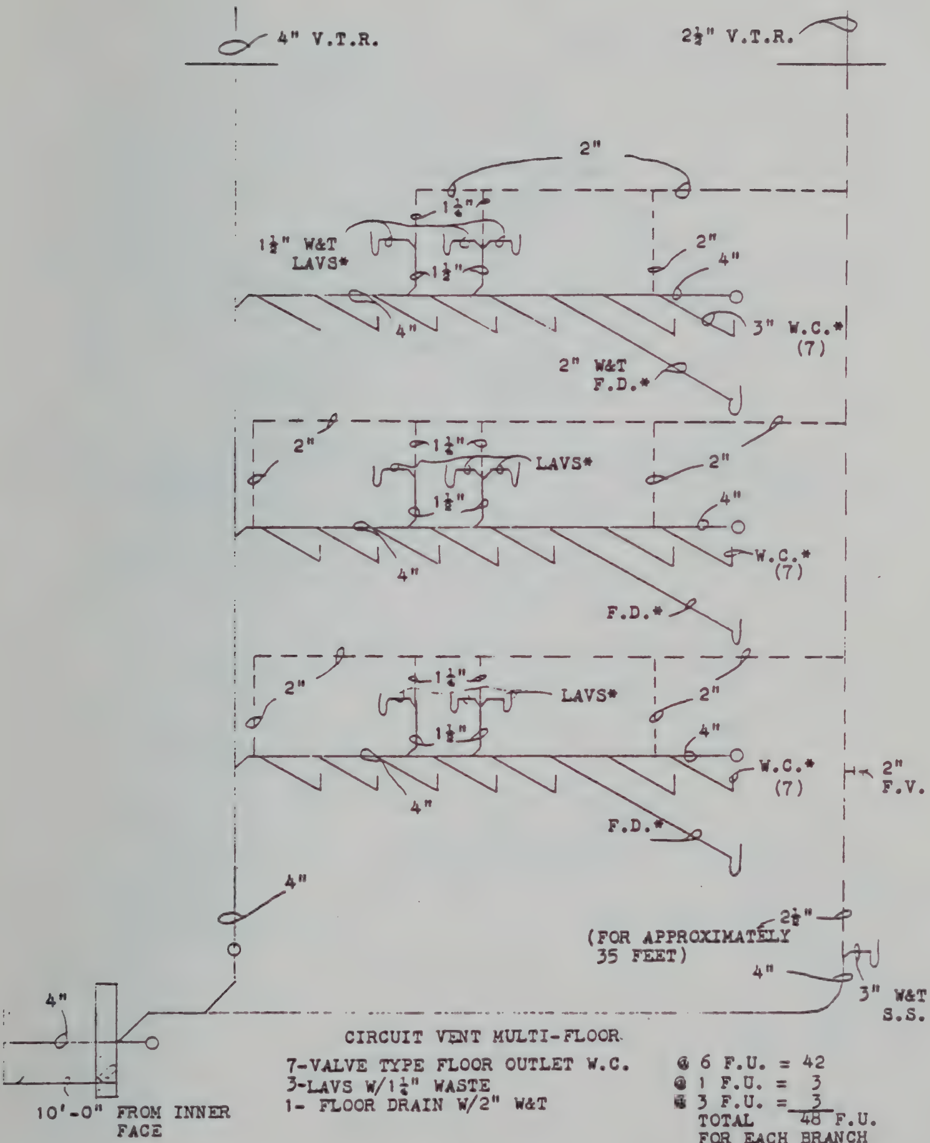

2" V.T.R.
4" V.T.R.
2" IF THE TOTAL LENGTH OF THE HORIZONTAL BRANCH VENT IS UNDER 35 FEET.
1¼"
1¼"
LAVS
1½" W&T LAVS*
2"
1½"
1½"
4"
(7) W.C'S.* (3")
2" W&T F.D.
2" F.V.
2" IF THE ENTIRE LENGTH OF THE VENT STACK IS UNDER 35 FEET
4"
4"
10'-0" FROM INNER FACE

CIRCUIT VENTING ONE BRANCH

7-TANK TYPE FLOOR OUTLET W.C.	@ 4 F.U. = 28
3-LAVS W/1¼" WASTE	@ 1 F.U. = 3
1-FLOOR DRAIN W/2" WASTE	@ 3 F.U. = 3
	TOTAL 34 F.U.

2.23: continued

FIGURE 8

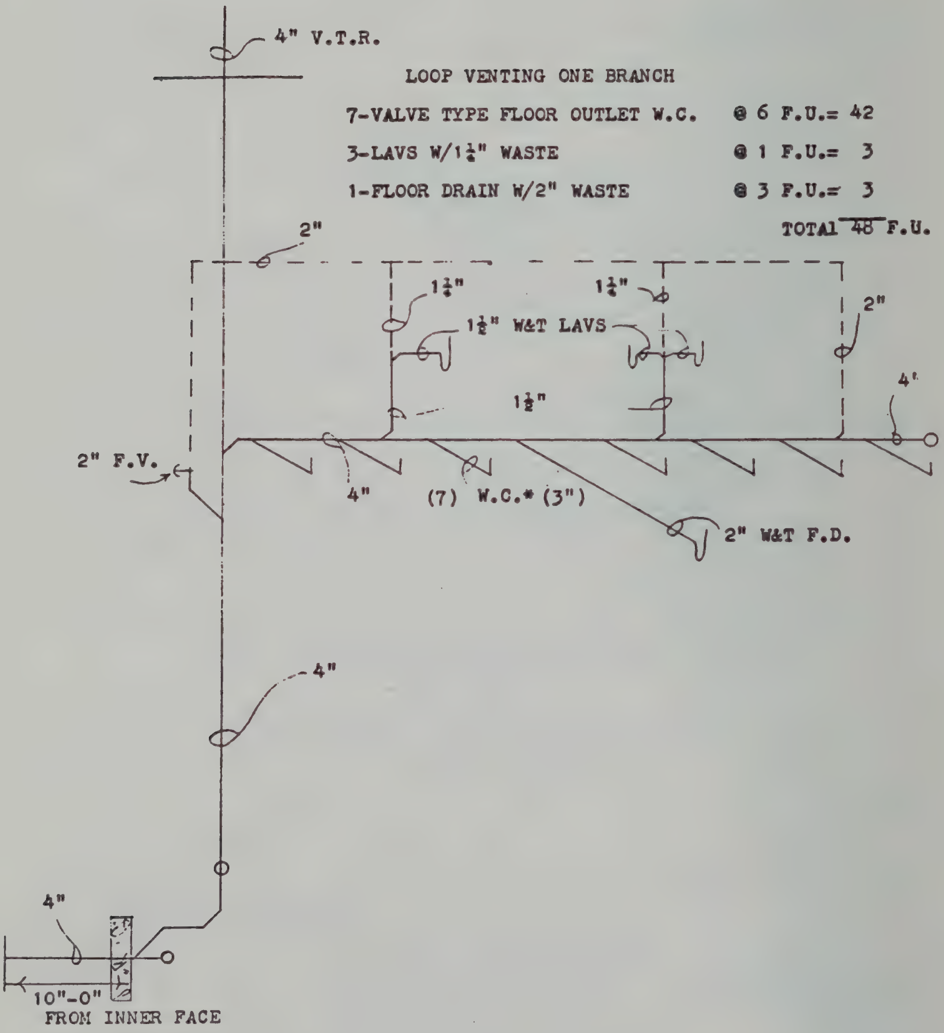


CIRCUIT VENT MULTI-FLOOR

7-VALVE TYPE FLOOR OUTLET W.C.	@ 6 F.U. = 42
3-LAVS W/1¼" WASTE	@ 1 F.U. = 3
1- FLOOR DRAIN W/2" W&T	@ 3 F.U. = 3
	TOTAL 48 F.U. FOR EACH BRANCH

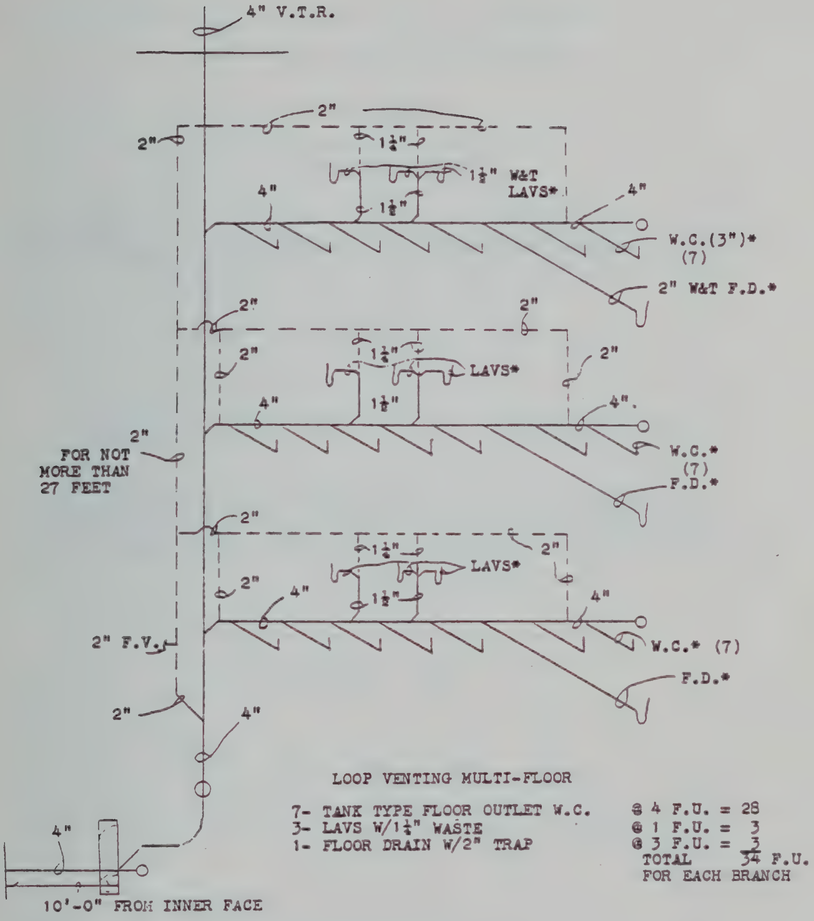
2.23: continued

FIGURE 9



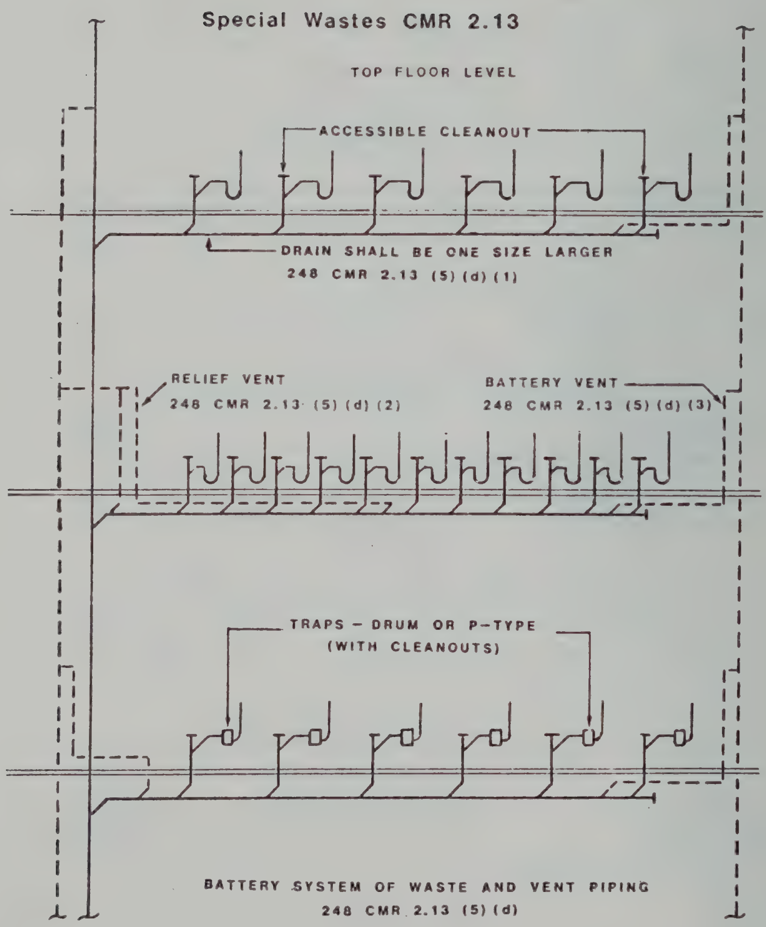
2.23: continued

FIGURE 10



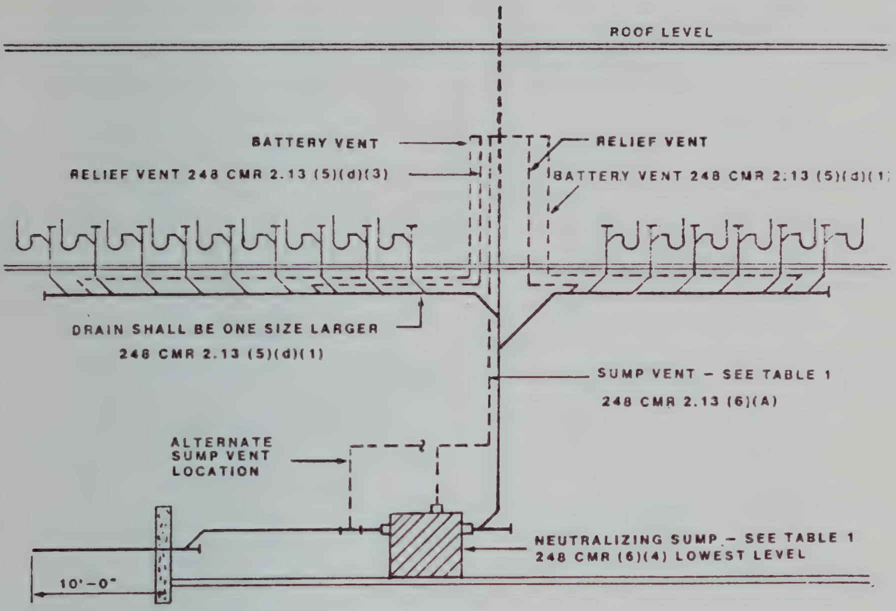
2.23: continued

FIGURE 11



2.23: continued

FIGURE 12


ROOF LEVEL
BATTERY VENT
RELIEF VENT
RELIEF VENT 248 CMR 2.13 (5)(d)(3)
BATTERY VENT 248 CMR 2:13 (5)(d)(1
DRAIN SHALL BE ONE SIZE LARGER
248 CMR 2.13 (5)(d)(1)
SUMP VENT – SEE TABLE 1
248 CMR 2.13 (6)(A)
ALTERNATE
SUMP VENT
LOCATION
NEUTRALIZING SUMP – SEE TABLE 1
248 CMR (6)(4) LOWEST LEVEL
10'–0"

2.23: continued

FIGURE 15

GENERAL CONSTRUCTION NOTES

BASIN TO BE LOCATED OUTSIDE OF BUILDING WHERE POSSIBLE, COVER TO HAVE A CENTER HOLE.

A TIGHT COVER MUST BE USED IF BASIN IS LOCATED INSIDE OF BUILDING

OPENING SHALL BE NOT LESS THAN 24" DIA.

THE CATCH BASIN SHALL BE SO LOCATED AND CONSTRUCTED THAT SURFACE WATER SHALL BE EXCLUDED

INLET PIPE SHALL BE AT LEAST FOUR INCHES ABOVE NORMAL WATER LINE.

WHERE SUBJECT TO FROST OR CRUSHING CONDITIONS, OUTLET SHALL BE AT LEAST THREE FEET BELOW THE SURFACE

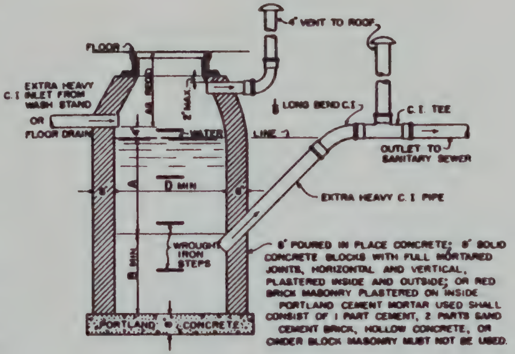
THE NEW CATCH BASIN MUST BE FILLED WITH CLEAN WATER BEFORE USING, AND AFTER BEING EMPTIED FOR PERIODIC CLEANING.

ALL OIL AND GASOLINE MUST BE REMOVED BEFORE CLEANING OUT THE BASIN, AND MUST NOT BE DISCHARGED INTO THE SEWER THROUGH OTHER FIXTURES

SPECIFICATIONS FOR COVERING SPECIAL CASES OR CONDITIONS, SHALL BE APPROVED BY THE LOCAL AUTHORITIES, AND THE AUTHORITIES OF THE COMMONWEALTH OF MASSACHUSETTS.

WROUGHT IRON STEPS SHALL BE SPACED ABOUT 18" APART

BOTH VENTS SHALL BE EXTENDED INDEPENDENTLY 18" ABOVE THE ROOF, OR AS APPROVED BY THE LOCAL AUTHORITIES, AND THE AUTHORITIES OF THE COMMONWEALTH OF MASSACHUSETTS.



8" POURED IN PLACE CONCRETE; 8" SOLID CONCRETE BLOCKS WITH FULL MORTARED JOINTS, HORIZONTAL AND VERTICAL, PLASTERED INSIDE AND OUTSIDE; OR RED BRICK MASONRY PLASTERED ON INSIDE

PORTLAND CEMENT MORTAR USED SHALL CONSIST OF 1 PART CEMENT, 2 PARTS SAND

CEMENT BRICK, HOLLOW CONCRETE, OR CINDER BLOCK MASONRY MUST NOT BE USED.

INLET	D	A	B
4"	3'-6"ø	3'-0"	2'-6"
5"	3'-6"ø 3'-6"x3'-6" 4'-0"ø 4'-0"x4'-0" 4'-6"ø	5'-0" 4'-0" 3'-6" 3'-0" 3'-0"	4'-0" 3'-0" 3'-0" 2'-6" 2'-6"
6"	4'-0"ø 4'-0"x4'-0" 4'-6"ø 4'-6"x4'-6" 5'-0"ø 5'-0"x5'-0"	5'-0" 4'-0" 4'-0" 3'-6" 3'-6" 3'-0"	4'-6" 3'-6" 3'-6" 3'-0" 3'-0" 2'-6"
8"	5'-0"ø 5'-6"x5'-6" 6'-0"ø 6'-0"x6'-0" 6'-6"ø 6'-6"x6'-6"	6'-0" 4'-6" 4'-0" 3'-0" 3'-6" 3'-0"	5'-0" 4'-0" 3'-6" 2'-6" 3'-0" 2'-6"

NOTE:

FOR INLETS LARGER THAN 8" THE DESIGN AND DIMENSIONS WILL BE DETERMINED FOR EACH PARTICULAR CASE.

CIRCULAR BASINS ARE RECOMMENDED.

THE COMMONWEALTH OF MASSACHUSETTS
METROPOLITAN DISTRICT COMMISSION
SEWERAGE DIVISION

APPROVED BY
DIRECTOR OF SEWERAGE DIVISION
AND CHIEF SEWERAGE ENGINEER

APPROVED BY
STATE FIRE MARSHALL

The Massachusetts Fuel Gas Code of the Board of State Examiners of Plumbers and Gas Fitters shall be the 1984 Edition of NFPA 54-ANSI Z223.1 National Fuel Gas Code with modifications, the 1983 Edition of NFPA 58 Standard for the Storage and Handling of Liquefied Petroleum Gases with modifications, and 248 CMR 7.00 Massachusetts Code For Gas Utilization Equipment in Large Boilers without modifications.

NFPA 58-1983 Standard for the Storage and Handling of Liquefied Petroleum Gases shall be modified for 248 CMR 6.00 as follows:

> Chapters 1, 2, and 3 as they apply to the use of Liquefied Petroleum Gas Systems not covered in NFPA 54-1984, have been adopted as the Code governing these systems. Reference to Storage Containers in Chapters 1, 2, and 3 shall be excluded as they are covered by FPR 527 CMR 6.00. Reference to Engine Fuel Systems and LP-Gas Systems on Vehicles in Chapter 3 shall also be excluded.

NFPA 54 - ANSI Z223.1 - 1984 the National Fuel Gas Code shall be modified for 248 CMR 5.00 as follows:

Delete pages i through ix and substitute the following:

> In accordance with the provisions of M.G.L., Chapter 142, Section 13, the Board of State Examiners of Plumbers and Gas Fitters herewith makes the following rules and regulations relative to the installation of fuel gas piping systems, fuel gas utilization equipment and related accessories throughout the Commonwealth.

Rule 1. Gas piping systems, in general, shall be low pressure (not in excess of 1/2 pound per square inch or 14 inches water column).

Rule 2. Permits to perform gas fitting shall be issued to licensed gas fitters and licensed plumbers only.

Rule 3. In cases of emergency a gas appliance may be turned on temporarily by the licensed installer provided: the installer has tested the piping in accordance with the appropriate section of this code; the installer and the supplier are satisfied that the installation of piping and use of the equipment will assure safe operation; and the gas inspector (or the chief inspector if more than one inspector) is notified and a regular inspection is made at the earliest opportunity in any case not later than the next working day.

Rule 4. Licensed persons acquiring gas permits for any location shall be responsible for such gas work and/or equipment specified in the permit until the permit is completed or withdrawn. All withdrawals must be in writing or in a manner prescribed by the Board of State Examiners of Plumbers and Gas Fitters.

Rule 5. No initial deliveries of propane gas shall be made to any installation without the supplier first ascertaining whether the permits have been approved by the local authorities. Alterations or additions to the original installation shall require reapproval and issuance of new permits.

Rule 6. Each trailer, having a gas system attached, that is used in any way for human occupancy shall be inspected by the local gas inspector in every location where such trailer is in use.

Rule 7. For the purpose of this code, the Gas Inspector shall be that person in each city or town appointed under the provisions of M.G.L. C142, ss. 11 and 12 having those qualifications spelled out under those sections.

Rule 8. An amendment to Part 192, Section 192.3 of the minimum Federal Safety Standards relating to transportation of Natural Gas and Other Gas by Pipeline (49 U.S.C. 1692) redefined a service line to mean a distribution line that transports gas from a common source to:

(a) a customer meter or the connection to a customer's piping, whichever is farther downstream or

(b) the connection to a customer's piping if there is no customer meter. A customer's meter is the meter that measures the transfer of gas from an operator to a customer.

Rule 9. The Office of Pipeline Safety, U.S. Department of Transportation, has interpreted that in some instances such as transportation of gas from a master meter or point of delivery by the utility by a customer to a connection with customer's piping as a building or series of buildings (such as a mobile home park, multiple housing complex) must be installed, maintained, and operated in accordance with federal regulations.

Rule 10. The adjusting of appliance controls, the adjusting of gas flames, the replacement of controls, the installation or replacing of meters and regulators, and the servicing of appliances shall be deemed work for which no permit shall be required (Utility Gas).

Rule 11. No gas system or part thereof shall be covered until it has been inspected, tested and accepted as prescribed in the Code.

Rule 12. The equipment, materials, power, and labor necessary for the inspection and test shall be furnished by the plumber or gas fitter.

Rule 13. Gas shall not be turned on to new or existing system which has been renovated unless the installation has been approved by the local gas inspector.

Rule 14. Whenever there is reason to believe that the gas system of any building has become defective, it shall be subjected to test and/or inspection, and any defects found shall be corrected as required in writing by the Inspector of Gas Fitting.

Rule 15. Whenever additional gas piping or alterations thereof is being made or installed, in the existing buildings or premises, and existing gas fitting is found to be in violation of this Code to the point of being a health menace or nuisance or a safety hazard, such existing gas fitting shall be made to conform before any additional work may be completed.

Rule 16. The local gas inspector shall, after proper identification, have the right to enter any premises for the purpose of inspecting any gas fitting system and at such times as may be reasonably necessary to protect the public safety.

Rule 17. When gas equipment which is connected to a gas system is to be permanently removed, a permit for the work shall be secured. All connections to such equipment shall be made gas tight.

Rule 18. Should a licensed plumber or gas fitter holding a gas permit for installation of gas work, turn on gas to such work, without first notifying the local gas inspector, he may not be granted any further gas permits upon the discretion of the local gas inspector.

Rule 19. Permits shall be invalid if the work is not started within 90 days of the date thereon, unless the holder of the permit can prove to the inspector that failure to start within the 90 day period was beyond his control.

Rule 20. If, at the time of testing and inspection, any leaks, defective or patched materials, or evidence of unskilled or inferior workmanship be found, the same shall be condemned by the Inspector of Gas Fitting and ordered by him to be removed and corrected and no further progress shall be allowed on the work until the same is completed and the test renewed.

Rule 21. The inspector shall, except in the case of emergencies, perform his duties and inspections during the normal working hours of the day.

Rule 22. Following the testing and approval of a gas system, the inspector shall attach a permanent tag in a conspicuous place indicating his approval of the system.

(RESERVED FOR FUTURE USE)

Penalty. Every person engaged in the business of master gas fitter or working as a journeyman or as an apprentice not lawfully registered or licensed as required by M.G.L. 142, every person engaging in or working at the business of gas fitting in a city or town, when forbidden to do so under M.G.L. 142, every master gas fitter who engages or employs any person to work as a journeyman or as an apprentice who has not been so registered or licensed, and any person violating any provisions of this Code shall be punished by a fine not exceeding one hundred dollars.

Appeal Procedure. Any person aggrieved by the decision of an Investigator or Inspector of Gas Fitting may appeal, in writing, to the Board of State Examiners of Plumbers and Gas Fitters for a hearing. The written appeal shall be accompanied with a check in the amount of twenty dollars made payable to the Commonwealth of Massachusetts, shall be filed by the appellant with the Executive Secretary who shall schedule the hearing and notify all interested parties of same.

Should the Board of State Examiners of Plumbers and Gas Fitters find in favor of the appellant, the check deposited with the Board shall be returned to the appellant.

The decision of the Board of State Examiners of Plumbers and Gas Fitters shall be final.

5.00 (amendments)

1.1. Revise Subsection (a) as follows:

Scope

In general, Code requirements apply only to low pressure (not in excess of 1/2 pound per square inch or 14 inches water column) gas piping systems extending from the outlet of the meter set assembly or the outlet of the service regulator when a meter is not provided, to the inlet connection of appliances, and the installation and operation of residential, commercial, and

Industrial gas appliances supplied through such system. They are intended to cover design, fabrication, installation, tests and operation of such systems for fuel gases of any kind, such as natural gas, manufactured gas, undiluted liquefied petroleum gases, liquefied petroleum gas-air mixtures, or mixtures of these gases.

Nothing in these regulations and standards shall conflict with the provisions of regulation No. 11725 of the Department of Public Utilities and nothing in these regulations and standards shall supersede or overrule any of the provisions of Chapter 142 of the Massachusetts General Laws or any code, rules, or regulations established under authority of Chapter 142 of the Massachusetts General Laws.

IN APPLYING THESE RULES AND REGULATIONS, REFERENCE SHOULD ALSO BE MADE TO THE MANUVACTURER'S INSTRUCTIONS, SERVING GAS SUPPLIER REGULATIONS, AND LOCAL BUILDING, HEATING, PLUMBING OR OTHER CODES IN EFFECT IN THE AREA IN WHICH THE INSTALLATION IS MADE.

2.1 Revise Subsection 2.1.1 as follows:

Permits and Piping Plans.
(a) Gas piping systems shall not be installed, altered, removed, replaced, or repaired until a permit has been issued therefore by the Inspector of Gas Fitting. Any application for such permit shall be made to the Inspector of Gas Fitting and shall contain a statement of the work to be performed, the location of the building, and the names of the persons for and by whom the work is to be done. All applications for permits for any new installations of natural gas-fired central and space heating equipment

shall be accompanied by authorization from the serving gas supplier. Such authorization shall also accompany all applications for permits to install any gas-fired equipment for commercial or industrial use. Replacements of existing gas-fired central or space heating and commercial or industrial equipment shall be excluded from the authorization, provided the gas input rating is not more than 110% of the equipment being replaced. Each permit which is issued by the Inspector of Gas Fitting shall be subject to the express conditions set forth therein as to compliance with all provisions of the statutes, rules and regulations which relate to gas fitting.

(b) Fees to obtain permits for gas fitting in a city or town, or in any building in such city or town, owned or operated by the Commonwealth or any political sub-division of the Commonwealth shall be determined by the city or town. Permits to perform gas fitting shall be issued by the local Gas Inspector.

(c) For gas installations of over 5,000,000 (five million) BTU/Hr, a plan of the proposed piping system and equipment shall be submitted for approval to the local Gas Inspector. This plan shall contain a written statement from the local gas supplier that such fuel demand is available. The system shall be designed by a Registered Professional Engineer.

(d) Gas piping systems requiring gas pressure in excess of 1/2 psig may be permitted with the approval of the Board of State Examiners of Plumbers and Gas Fitters. This pressure limitation does not apply to LP Liquid Gas Systems and/or first stage vapor systems.

2.6.2 Revise Subsection (a) as follows and delete Subsection (b) (4).

(a) Cast-iron and Galvanized Pipe shall not be used.

2.12 Revise the section as follows:

2.12 Acceptable Shutoff Devices
Gas Cocks and Ball Valves installed for use shall either be listed by a nationally recognized testing agency or comply with applicable American Standard Approval or Listing Requirements and shall be approved by the Board of State Examiners of Plumbers and Gas Fitters. They shall:

1. Have clearly indicated open and closed positions and rigidly secured stops to limit both extremes of rotation. Ball Valves shall be Tee Handle Type.
2. Show no evidence of leakage when subjected to an air pressure test of 2" inches mercury column (1 psig) for 10 minutes.
3. Be capable of withstanding without deformation, breakage or leakage the following turning effort when screwed onto a pipe fitting:

Nominal Pipe Size		Turning Effort	
1/2	inch	300	inch-pounds
3/4	inch	450	inch-pounds
1	inch	600	inch-pounds
1-1/4	inch	700	inch-pounds
1-1/2	inch	750	inch-pounds
2	inch	950	inch-pounds
2-1/2	inch	1050	inch-pounds
3	inch	1050	inch-pounds

4. Have a capacity not less than that specified in the following table for 0.60 Specific Gravity, 1000 BTU Per Cubic Foot Gas at a 1.0" inch water column pressure drop.

Nominal Pipe Size	Minimum Capacity
1/2 inch	260,000 BTU Per hour
3/4 inch	698,000 BTU Per Hour
1 inch	1,192,000 BTU Per Hour
1-1/4 inch	1,768,000 BTU Per Hour
1-1/2 inch	3,097,000 BTU Per Hour
2 inch	5,346,000 BTU Per Hour
2-1/2 inch	6,859,000 BTU Per Hour
3 inch	11,923,000 BTU Per Hour

5. Each valve shall be marked in a conspicuous place with the manufacturer's name or trade mark.

(Testing procedures for 2, 3, and 4 above shall be consistent with those outlined in the American National Standard for Manually Operated Gas Valves).

2.14 Add a new section as follows:

Installation of Consumer-Owned Gas Pressure Boosters.
(a) When Permissible: When written approval has been granted by the serving gas supplier, consumer-owned gas pressure boosters may be installed in that portion of the gas piping system extending from the outlet of the meter set assembly to the inlet of the equipment requiring the elevated pressure.

(b) Type: Gas pressure boosters shall be of the hermetically sealed type. Any exception to this provision shall require approval of the Board of State Examiners of Plumbers and Gas Fitters.

(c) Proper Location:

1. Gas pressure boosters shall be installed on a firm foundation or concrete floor and shall be free of vibration.

2. Gas pressure boosters shall be located in well ventilated spaces and readily accessible for examination, replacement or necessary maintenance.

(d) Underpressure Protection Device: A manual reset low pressure shutoff device shall be installed between the gas pressure booster and the gas meter to protect against a reduction in supply pressure lower than that acceptable to the serving gas supplier.

(e) Additional Provisions:

1. Gas pressure boosters shall be installed and maintained in accordance with the manufacturer's instructions.

2. The gas equipment, for which the booster is required, shall be equipped with a properly set, low gas pressure switch that will prove the correct pressure is available before startup.

3.10.3 Revise the section as follows:

3.10.3 Emergency Shutoff Valves: Whenever a gas meter is installed on the outside of a building, there shall be an emergency shutoff valve immediately inside the foundation (wall) on the house side of meter.

4.1 Revise the section as follows:

Pressure Testing and Inspection

(a) Before any system of gas piping is finally put in service, it shall be carefully tested in the presence of, and with the approval of, the gas inspector to insure that it is gastight. Where any part of the system is to be enclosed or concealed, this test shall precede the work of closing in. The test medium shall be air or inert gas (e.g., nitrogen, carbon dioxide). OXYGEN SHALL NEVER BE USED.

(b) Gas piping systems, not in excess of 1/2 psig or 14 inches water column, extending from the outlet of the meter set assembly to the closed shutoff valve of each appliance, shall withstand a pressure of a least 6 inches mercury or 3 pounds gauge for a period of not less than ten minutes without showing any drop in pressure. Pressure shall be measured with a mercury manometer or slope gauge, or an equivalent device so calibrated as to be read in increments of not greater than one-tenth pound. The source of pressure shall be isolated before the pressure tests are made.

(c) If an additional appliance is connected to a gas piping system previously installed, the additional piping shall be isolated and tested to a pressure of at least 6 inches of mercury or 3 pounds gauge for a period of not less than 10 minutes without showing any drop in pressure and the remainder of the piping system previously installed may be tested to not more than 3 inches of mercury or 1 1/2 pounds gauge for a period of not less than 10 minutes without showing any drop in pressure.
(d) Gas piping systems for industrial and other large installations shall be tested at a pressure at least 10 times (maximum 100 psig) the proposed maximum working pressure. Test duration shall be long engough to determine if there are any leaks but not less than one hour for each 100 linear feet of pipe or fraction thereof. The duration of the test need not exceed 24 hours irrespective of system design.
(e) Gas piping systems for undiluted liquefied petroleum gases shall be tested at a pressure no less than 1 1/2 times the proposed working pressure, but not less than 3 psig, irrespective of design pressure, or for systems operating at a pressure of 1/2 psig or less when appliances are connected to the piping system, shall withstand a pressure of not less than 10.0 inches nor more than 14.0 inches water column for a period of not less than 10 minutes without showing any drop in pressure. The source of pressure shall be isolated before the pressure tests are made.

(f) All piping before the low pressure regulator in undiluted liquefied petroleum gas systems shall be tested using a pressure gauge at a maximum operating pressure of tank or container for a period of not less than 10 minutes without any drop in pressure.
(g) After the test of piping for tightness as described in (a) through (f), gas may be turned on and appliances tested at normal operating pressure by means of a soap bubble test, or other non-corrosive foaming agent test.

5.1.1 Revise the section as follows:

Appliances, Accessories, and Equipment to Comply with Standard Requirements. All gas appliances, accessories and gas utilization equipment shall comply as follows:
(a) be certified by the American Gas Association or other nationally recognized testing agency, constructed in accordance with applicable American National Standards (ANSI), and approved by the Board of State Examiners of Plumbers and Gas Fitters.
(b) if not certified by the American Gas Association or other nationally recognized testing agency acceptable to the Board of State Examiners of Plumbers and Gas Fitters, it shall not be installed unless approved by the local Gas Inspector in accordance with the Procedures for The Initial Operation of Industrial Gas Equipment.
(c) A List of Reference Standards acceptable to the Board of State Examiners of Plumbers and Gas Fitters is provided in Appendix A of NFPA 54-Z223.1 -1984. It may be referred to for the installation of specific equipment.

5.5.1 Add to Subsection (c) as follows:

1. Such connectors must be designed and certified by a nationally recognized testing agency and must be certified under the provisions of American National Standard for Metal Connectors for Gas Appliances, Z21.24.
2. Only those connectors incorporating connector nuts using threads which are incapable of being assembled to standard taper pipe threads shall be acceptable.
3. Unless the external surface of the connector is stainless steel, the external surfaces of all connectors shall be coated with a material to protect the connector from those chemical reactions with atmospheric contaminants which could weaken the connector.
4. The use of connectors shall be limited to:
    (a) Built-in domestic cooking units that provide at least one function of (1) top or surface cooking, (2) oven cooking or (3) broiling, and that are designed to be recessed into, placed upon, or placed between counters and between cabinets.
    (b) Built-in Type I, clothes dryers that are designed to be recessed into, placed upon or placed between counters and between cabinets.
5. Only a single connector shall be used on each appliance.
6. No connector shall be re-used except for disconnecting and reconnecting the original appliance for servicing.
7. No connector shall be used on pressures in excess of one-half (1/2) pound per square inch gauge (psig).

6.1 In subsection (a) revise the last sentence of the first paragraph as follows:

Unlisted equipment or accessories shall be prohibited unless approved by the Board of State Examiners of Plumbers and Gas Fitters and/or the local Gas Inspector.

In Subsection (b) revise as follows and add new Subsections (c), (e), and (f).

(b) Gas utilization equipment shall not be installed so its combustion and ventilation air is obtained from a bedroom or bathroom.

(c) The use of gas range ovens, broilers, or top burners for space heating shall be prohibited.

(d) The installation of gas ranges with match-lit ovens shall be prohibited.

(e) The installation of any listed or unlisted commercial cooking range without a listed type oven safety pilot shall be prohibited.

(f) Unlisted commercial cooking equipment, floor mounted and counter type, equipped with listed safety controls and installed with clearances specified in Sections 6.5 and 6.6 may be approved by the local Gas Inspector.

6.4.2 Revise Subsection (a) as follows:

(a) Type 1 clothes dryers shall be exhausted to the outside air.

6.5.8 Add a new Subsection as follows:

Thermally Actuated Gas Shutoff Valves Used for Commercial Cooking Equipment (In-Line Gas Valves).

(a) When in-line gas valves are used for fire protection, the installation of these valves shall conform to the following regulations:

1. Only a qualified installer shall install an in-line gas valve in new or existing gas piping for the purpose of shutting off gas in hotel and restaurant commercial cooking equipment.
2. All in-line gas valves shall be of the mechanical type with manual reset and shall be installed in close proximity to the equipment and shall shut off gas to the equipment served by the hood and duct system protected by the extinguisher.
3. A plan of the "Mechanical Fuel Shutoff System" shall be submitted to local Gas Inspector prior to any installation.
4. A wiring and gas piping plan in which an electrically operated gas valve may be necessary for certain equipment shall be submitted to the Board of State Examiners of Plumbers and Gas Fitters for approval. When approved by the Board, a copy of this plan shall be submitted to the local Gas Inspector.

(5) When an in-line gas valve is used in conjunction with a fire prevention system, a permanent notice shall be posted at the reset device and gas meter or propane regulator cautioning the operator to shut off the gas to all appliances before resetting the device.

6. Actuation of the in-line gas valve shall be made in the presence of the Gas Inspector at the time of the piping tests.
7. An annual inspection certificate shall be submitted to the Gas Inspector certifying that the in-line gas valve is in working condition.
8. In any case not covered by these provisions, contact the Board of State Examiners of Plumbers and Gas Fitters for a ruling.

6.10.1 Add a second sentence as follows:

The specifications for direct make-up air heaters shall require that there be no more than 50 ppm of Carbon Monoxide in the total volume of air discharged from the unit.

6.23.1 Revise the section as follows:

Installations in Sleeping Quarters or Bathrooms: Listed room heaters may be installed in residential sleeping quarters or bathrooms; and such quarters as those for transients in hotels, motels, and auto courts with the approval of the local Gas Inspector, provided:
(a) The gas flame is sealed from the room air.
(b) The combustion chamber is vented to the outside air through two passages; one for inlet air for combustion, the other a proper passage for the products of combustion. These vent terminals shall be located not less than eighteen inches from any building opening unless the manufacturer's instructions provide for less, but in no case shall they be installed less than nine inches from any building opening.

(c) The combustion chamber and heat exchanger are ceramic-coated metal or with refractory tile inner lining or aluminized steel or if cast iron or not less than 12 gauge furnace steel, or stainless steel or equivalent.
(d) The structural members supporting the unit are designed to support a concentrated load equivalent to two and one-half times the aggregate total load of the unit without exceeding the allowable working stresses in the material permitted by the code of the municipality in which the structure is erected.

6.23.5 Add a new Section as follows:

Unvented Room Heaters shall be prohibited.

6.25 Add new Sections as follows:

6.25.1 Solenoid Valve: Gas engines shall be equipped with an automatic solenoid gas valve electrically connected to the ignition circuit of the engine that closes whenever the engine stops running.

6.25.2 Flexible Connectors:
(a) Engines operating at gas pressure of 15 psig or less connected to generator of 15 KW or less may use a flexible neoprene hose bearing the manufacturer's name and acceptance for LP or Natural Gas service.
(b) Engines operating at gas pressures above 15 psig connected to generators with an output of 15 KW or more shall use a flexible connector approved by the Board of State Examiners of Plumbers and Gas Fitters. A list of approved

flexible connectors shall be kept on file with the Board of State Examiners of Plumbers and Gas Fitters.

6.25.3 Fuel Supply: Fuel lines to gas engines shall be supplied only from hard case gas meters.

6.30 Add a new Section as follows:

Gas-Fired Kilns

Plans for the design and installation of customer made ceramic and pottery kilns shall be submitted to the Board of State Examiners of Plumbers and Gas Fitters for approval.

(RESERVED FOR FUTURE USE)

7.9.3 Revise last sentence of Subsection (a) as follows:

As an alternate method the effective area of the connector shall not be less than the area of the draft hood outlet and shall be equal to or greater than the size shown in the following table.

TABLE

Allowable Input to Vent Connectors*
Before Interconnection

Vent Connector Diameter	Maximum Allowable Input in BTU Per Hour
3"	40,000
4"	75,000
5"	110,000
6"	160,000
7"	220,000
8"	290,000
9" and above	6,000 Btu/sq. in. of cross-sectional area

*Vent connector diameters for central heating appliances may be smaller than the above allowances but shall not be smaller than the size of the draft hood outlet.

Part 8 Delete Sections 8.1 through 8.8 and revise as follows:

Procedures for Initial Operation of Industrial Gas Equipment

8.1.1 General

a. The following procedures are to be followed in connection with initial operation of gas equipment, necessary adjustments, development of operating instructions, instruction of the operator in the safe and satisfactory use of the equipment and required acceptance tests.

b. Competent, well trained personnel shall be used to start; to light; to adjust burners, mixers, flames, blowers, temperature controls and protective devices; and to shut down.

8.1.2 New Gas Equipment Procedures.

a. Before initial start, it shall be determined by physical check that all protective devices are connected and operative, the installation is in all respects capable of safe operation, the equipment has been purged in accordance with manufacturer's instructions, and that all concerned persons have been notified.

b. Initial Start-up and Final Adjustments. An authorized representative of the gas equipment manufacturer shall perform the initial startup, final adjusting and testing of the burner and controls in the presence of the gas inspector and gas company representative.

c. Operation. Installed protective devices shall be tested under operating conditions as promptly as possible to determine that they are functioning properly. Other instruments and controls should also be tested in the same manner. Gas equipment shall be shut down immediately if any defect is noted during initial startup or operation. Defects shall be corrected before the equipment is again started. In shutting down equipment, manufacturer's instructions and applicable safety requirements shall be followed.

d. Adjustments. Adjustments to burners, pilots, ignition devices, protective devices, and controls shall be made in accordance with manufacturer's instructions and applicable safety requirements.

8.1.3 Operating Instructions

Operating instructions, as supplied by equipment manufacturers, shall be assembled and integrated into a system, delivered to the user, and the operator instructed in their use in order to assure safe and satisfactory operation of the equipment.

8.1.4 Acceptance Tests.

Acceptance tests shall be conducted if necessary to establish compliance with applicable codes or requirements of authorities having jurisdicution.

Regulatory Authority

248 CMR 5.00 M.G.L. c.142, s.13.
248 CMR 6.00 M.G.L. c.142, s.13.

248 CMR 5.00: MASSACHUSETTS FUEL GAS CODE
NFPA 54, 1984 - ANSI Z 223.1, 1984
CONTENTS

Page

PART 1 — GENERAL

1.1 Scope 1
1.2 Alternate Materials, Equipment and Procedures 2
1.3 Retroactivity 3
1.4 Qualified Agency 3
1.5 Interruption of Service 3
1.6 Prevention of Accidental Ignition 4

PART 2 — GAS PIPING SYSTEM DESIGN, MATERIALS AND COMPONENTS

2.1 Piping Plan 5
2.2 Provision for Location of Point of Delivery 5
2.3 Interconnections Between Gas Piping Systems 5
2.4 Sizing of Gas Piping Systems 5
2.5 Piping System Operating Pressure Limitations 7
2.6 Acceptable Piping Materials and Joining Methods 8
2.7 Gas Meters 14
2.8 Gas Pressure Regulators 15
2.9 Overpressure Protection Devices 16
2.10 Back Pressure Protection 19
2.11 Low Pressure Protection 19
2.12 Shutoff Valves 19
2.13 Expansion and Flexibility 20

PART 3 — GAS PIPING INSTALLATION

3.1 Piping Underground 21
3.2 Aboveground Piping Outside 22
3.3 Piping in Buildings 23
3.4 Concealed Piping in Buildings 24
3.5 Piping in Vertical Chases 25
3.6 Gas Pipe Turns 26

3.7 Drips and Sediment Traps 27
3.8 Outlets 27
3.9 Branch Pipe Connection 28
3.10 Manual Gas Shutoff Valves (Also see 5.5.4) 28
3.11 Prohibited Devices 29
3.12 Systems Containing Gas-Air Mixtures Outside the Flammable Range 29
3.13 Systems Containing Flammable Gas-Air Mixtures 29
3.14 Electrical Bonding and Grounding 32
3.15 Electrical Circuits 33
3.16 Electrical Connections 33

PART 4 – INSPECTION, TESTING AND PURGING

4.1 Pressure Testing and Inspection 34
4.2 System and Equipment Check 37
4.3 Purging 37

PART 5 – EQUIPMENT INSTALLATION

5.1 General 39
5.2 Accessibility and Clearance 44
5.3 Air for Combustion and Ventilation 45
5.4 Equipment on Roofs 50
5.5 Equipment Connections to Building Piping 51
5.6 Electrical 53
5.7 Room Temperature Thermostats 54

PART 6 – INSTALLATION OF SPECIFIC EQUIPMENT

6.1 General 55
6.2 Air Conditioning Equipment 55
6.3 Central Heating Boilers and Furnaces 57
6.4 Clothes Dryers 64
6.5 Commercial Cooking Equipment, Floor-Mounted 66
6.6 Commercial Counter Appliances 68
6.7 Conversion Burners 69
6.8 Decorative Appliances for Installation in Vented Fireplaces 69
6.9 Decorative Appliances, Vented 70

6.10 Direct Make-Up Air Heaters 70
6.11 Duct Furnaces 73
6.12 Floor Furnaces 75
6.13 Hot Plates and Laundry Stoves 77
6.14 Household Cooking Appliances 77
6.15 Illuminating Appliances 79
6.16 Incinerators, Commercial-Industrial 81
6.17 Incinerators, Domestic 81
6.18 Infrared Heaters 83
6.19 Open Top Broiler Units 84
6.20 Outdoor Cooking Appliances 84
6.21 Pool Heaters 84
6.22 Refrigerators 85
6.23 Room Heaters 86
6.24 Sauna Heaters 87
6.25 Stationary Gas Engines 90
6.26 Gas-Fired Toilets 90
6.27 Unit Heaters 90
6.28 Wall Furnaces 91
6.29 Water Heaters 92

PART 7 – VENTING OF EQUIPMENT

7.1 Specification for Venting 96
7.2 Minimum Safe Performance 97
7.3 Type of Venting System to be Used 98
7.4 Masonry, Metal and Factory-Built Chimneys 99
7.5 Type B, Type B-W and Type L Vents 102
7.6 Single-Wall Metal Pipe 104
7.7 Venting System Location 106
7.8 Outside Vents and Chimneys 107
7.9 Vent Connectors 107
7.10 Draft Hoods and Draft Controls 113
7.11 Manually Operated Dampers 116
7.12 Automatically Operated Vent Dampers 116
7.13 Obstructions 116
7.14 Special Venting Arrangements 116

PART 8 – PROCEDURES TO BE FOLLOWED TO PLACE EQUIPMENT IN OPERATION

8.1 Adjusting the Burner Input 118
8.2 Primary Air Adjustment 118
8.3 Safety Shutoff Devices 119
8.4 Automatic Ignition 119
8.5 Protective Devices 119

8.6 Checking the Draft 119
8.7 Operating Instructions 119
8.8 Notification of Completion 122

PART 9 – MODIFICATIONS TO EXISTING APPLIANCE INSTALLATIONS FOR THE PURPOSE OF FUEL CONSERVATION
9.1 Safety Inspection 123
9.2 Reduction of Vent Connector Size 123
9.3 Automatic Vent Damper Device Installation 123

PART 10 – DEFINITIONS 124

APPENDIX A – List of Reference Standards 151

APPENDIX B – Coordination of Gas Utilization Equipment Design, Construction and Maintenance 158

APPENDIX C – Sizing and Capacities of Gas Piping 163

APPENDIX D – Suggested Method for Checking for Leakage 184

APPENDIX E – Suggested Emergency Procedure for Gas Leaks 186

APPENDIX F – Flow of Gas Through Fixed Orifices 187

APPENDIX G – Sizing of Venting Systems Serving Appliances Equipped With Draft Hoods and Appliances Listed for Use With Type B Vents 194

APPENDIX H – Recommended Procedure for Safety Inspection of an Existing Appliance Installation 206

APPENDIX I – Recommended Procedure for Installing Electrically Operated Automatic Vent Damper Devices on Existing Appliances .. 208

APPENDIX J – Recommended Procedure for Installing Mechanically Actuated Automatic Vent Damper Devices on Existing Appliances .. 211

APPENDIX K – Recommended Procedure for Installing Thermally Actuated Automatic Vent Damper Devices on Existing Appliances .. 214

NATIONAL FUEL GAS CODE
ANSI Z223.1-1984 NFPA 54-1984

Notice: Information on referenced documents may be found in Appendix A.

PART 1

GENERAL

1.1 Scope.

1.1.1 Applicability:

a. This Code is a safety code which applies to the installation of fuel gas piping systems, fuel gas utilization equipment and related accessories as follows:

1. Fuel gases include natural gas, manufactured gas, liquefied petroleum (LP) gas in the vapor phase only, liquefied petroleum gas-air mixtures, and mixtures of these gases, plus gas-air mixtures within the flammable range, with the fuel gas or the flammable component of a mixture being a commercially distributed product.
2. Coverage of piping systems extends from the point of delivery to the connections with each gas utilization device. For other than undiluted liquefied petroleum gas systems, the point of delivery is the outlet of the service meter assembly, or the outlet of the service regulator or service shutoff valve when no meter is provided. For undiluted liquefied petroleum gas systems, the point of delivery is the outlet of the first stage pressure regulator.
3. The maximum operating pressure is 60 psig, except that piping systems for gas-air mixtures within the flammable range are limited to a maximum pressure of 10 psig.
4. Coverage of piping systems includes design, materials, components, fabrication, assembly, installation, testing, inspection, operation and maintenance.
5. Coverage of gas utilization equipment and related accessories includes installation, combustion and ventilation air, and venting.

b. This Code does not apply to the following (reference standards for some of which appear in Appendix A):

1. Portable LP-gas equipment of all types which are not connected to a fixed fuel piping system.

2. Installation of farm equipment such as brooders, dehydrators, dryers and irrigation equipment.
3. Raw material (feed stock) applications except for piping to special atmosphere generators.
4. Oxygen-fuel gas cutting and welding systems.
5. Industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen.
6. Petroleum refineries, pipeline compressor or pumping stations, loading terminals, compounding plants, refinery tank farms and natural gas processing plants.
7. Large integrated chemical plants or portions of such plants where flammable or combustible liquids or gases are produced by chemical reactions or used in chemical reactions.
8. LP-gas installations at utility gas plants.
9. Liquefied natural gas (LNG) installations.
10. Fuel gas piping in power and atomic energy plants.
11. Proprietory items of equipment, apparatus or instruments such as gas generating sets, compressors and calorimeters.
12. LP-gas equipment for vaporization, gas mixing and gas manufacturing.
13. LP-gas piping for buildings under construction or renovations which is not to become part of the permanent building piping system, i.e., temporary fixed piping for building heat.
14. Installation of LP-gas systems for railroad switch heating.
15. Installation of LP-gas and compressed natural gas (CNG) systems on vehicles.
16. Gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas, other than undiluted LP-gas.

1.1.2 Other Standards: In applying this Code, reference should also be made to the manufacturer's instructions and the serving gas supplier regulations. For a list of standards specifically referenced in applying this Code and other standards which may be used, see Appendix A.

1.2 Alternate Materials, Equipment and Procedures.

The provisions of this Code are not intended to prevent the use of any material, method of construction, or installation procedure not specifically prescribed by this Code, provided any such alternate is acceptable to the authority having jurisdiction. The authority having jurisdiction shall require that sufficient evidence be submitted to substantiate any claims made regarding the safety of such alternates.

1.3 Retroactivity.

Unless otherwise stated, it is not intended that the provisions of this Code be retroactive to existing systems in compliance with the provisions of the code in effect at the time of installation.

1.4 Qualified Agency.

Installation and replacement of gas piping, gas utilization equipment or accessories and repair and servicing of equipment shall be performed only by a qualified agency. The term "qualified agency" means any individual, firm, corporation or company which either in person or through a representative is engaged in and is responsible for (a) the installation or replacement of gas piping or (b) the connection, installation, repair, or servicing of equipment, who is experienced in such work, familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction.

1.5 Interruption of Service.

1.5.1 Notification of Interrupted Service: Except in the case of an emergency, it shall be the duty of the qualified agency, when the gas supply is to be turned off, to notify all affected users.

When two or more users are served from the same supply system, precautions shall be exercised to assure that only service to the proper user is turned off.

1.5.2 Before Turning Gas Off: Before turning off the gas to the premises, or section of piping to be serviced, for the purpose of installation, repair, replacement or maintenance of gas piping or gas utilization equipment, all equipment valves shall be turned off.

A leakage test shall be made, as specified in Appendix D, to determine that all equipment is turned off in the piping section to be affected.

1.5.3 Turn Gas Off: All gas piping installations, equipment installations and modifications to existing systems shall normally be performed with the gas turned off to eliminate hazards from leakage of gas, except as outlined in "b" below.

a. Reduce gas pressure and purge section to be worked on as specified in 4.3.

b. Hot taps may be made if they are installed by trained and experienced crews utilizing equipment specifically designed for such purpose.

1.5.4 **Work Interruptions:** When interruptions in work occur while repairs or alterations are being made to an existing piping system, the system shall be left in safe condition, such as by not leaving any open-ended piping.

1.6 Prevention of Accidental Ignition.

1.6.1 **Potential Ignition Sources:** When working on piping which contains or has contained gas:

a. Provisions for electrical continuity shall be made before alterations are made in a metallic piping system.

b. Smoking, open flames, lanterns, welding or other sources of ignition shall not be permitted.

c. A metallic electrical bond shall be installed around the location of cuts in metallic gas pipes made by other than cutting torches. If cutting torches, welding or other sources of ignition are unavoidable, it shall be determined that all sources of gas or gas-air mixtures have been secured and that all flammable gas or liquids have been cleared from the area. Piping shall be purged as required in 4.3 before welding or cutting with a torch is attempted.

d. Artificial illumination shall be restricted to listed safety type flashlights and safety lamps. Electric switches shall not be operated, on or off.

1.6.2 **Handling of Flammable Liquids:**

a. **Drip Liquids:** Liquid which is removed from a drip in existing gas piping shall be handled cautiously to avoid spillage or ignition and the gas supplier shall be notified.

b. **Other Flammable Liquids:** Flammable liquids used by the installer shall be handled with proper precautions and shall not be left within the premises from the end of one working day to the beginning of the next.

PART 2

GAS PIPING SYSTEM DESIGN, MATERIALS AND COMPONENTS

2.1 Piping Plan.

2.1.1. Installation of Piping System: When required by the authority having jurisdiction, a piping sketch or plan shall be prepared before proceeding with the installation. This plan shall show the proposed location of piping, the size of different branches, the various load demands and the location of the point of delivery.

2.1.2 Addition to Existing System: When connecting additional gas utilization equipment to a gas piping system, the existing piping shall be checked to determine if it has adequate capacity (see 2.4.3). If inadequate, the existing system shall be enlarged as required or separate gas piping of adequate capacity shall be provided.

2.2 Provision for Location of Point of Delivery.

The location of the point of delivery shall be acceptable to the serving gas supplier.

2.3 Interconnections Between Gas Piping Systems.

2.3.1 Interconnections Supplying Separate Users: When two or more meters, or two or more service regulators when meters are not provided, are located on the same premises and supply separate users, the gas piping systems shall not be interconnected on the outlet side of the meters or service regulators.

2.3.2 Interconnections for Stand-By Fuels: When a supplementary gas for stand-by use is connected downstream from a meter or a service regulator when a meter is not provided, a suitable device to prevent backflow shall be installed. A three-way valve installed to admit the stand-by supply and at the same time shut off the regular supply may be used for this purpose.

2.4 Sizing of Gas Piping Systems.

2.4.1 General Considerations: Gas piping shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand without undue loss of pressure between the point of delivery and the gas utilization equipment. The size of gas piping depends upon the following factors:

a. Allowable loss in pressure (see 2.4.4) from point of delivery to equipment.

b. Maximum gas demand.

c. Length of piping and number of fittings.

d. Specify gravity of the gas.

e. Diversity factor.

f. Foreseeable future demand.

2.4.2 **Maximum Gas Demand:** The volume of gas to be provided (in cubic feet per hour) shall be determined directly from the manufacturer's input ratings of the gas utilization equipment served. When input rating is not indicated, the gas supplier, equipment manufacturer, or a qualified agency shall be contacted for estimating the volume of gas to be supplied.

> NOTE: To obtain the cubic feet per hour of gas required, divide the Btu per hour rating by the Btu per cubic foot heating value of the gas supplied. The heating value of the gas may be obtained from the local gas supplier.

The total connected hourly load shall be used as the basis for piping sizing since all equipment may be operating at full capacity simultaneously. If, however, a diversity of load can be established, smaller sized piping may be used.

In case the ratings of the equipment to be installed are not known, Table C-1 of Appendix C shows the approximate demand of typical appliances by types.

2.4.3 **Gas Piping Size:** The gas-carrying capacities for different sizes and lengths of iron pipe, or equivalent rigid pipe, and semi-rigid tubing are shown in the capacity tables given in Appendix C.

Tables C-3 to C-14 in Appendix C indicate approximate capacities for single runs of piping. If the specific gravity of the gas is other than 0.60, correction factors shall be applied. Correction factors for use with these tables are given in Table C-15.

For any gas piping system, for special gas utilization equipment or for conditions other than those covered by the capacity tables in Appendix C, such as longer runs, greater gas demands, or greater pressure drops, the size of each gas piping system shall be determined by standard engineering methods acceptable to the authority having jurisdiction.

A suggested procedure with an example of using tables to size a gas piping system is presented in Appendix C.

2.4.4 Allowable Pressure Drop: The design pressure loss in any piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the gas utilization equipment, shall be such that the supply pressure at the equipment is greater than the minimum pressure required for proper equipment operation.

2.5 Piping System Operating Pressure Limitations.

2.5.1 Maximum Design Operating Pressure: The maximum design operating pressure for piping systems located inside buildings shall not exceed 5 psig unless approved by the authority having jurisdiction and one or more of the following conditions are met:

a. The piping system is welded.

b. The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.

c. The piping is located inside buildings or separate areas of buildings used exclusively for:
  1. Industrial processing or heating;
  2. Research;
  3. Warehousing; or
  4. Boiler or mechanical equipment rooms.

d. The piping is a temporary installation for buildings under construction.

2.5.2 Gas-Air Mixture Systems: Piping systems for gas-air mixtures within the flammable range are limited to a maximum pressure of 10 psig.

2.5.3 Liquefied Petroleum Gas Systems: In no case shall the maximum design operating pressure for undiluted LP-gas systems exceed 20 psig, except for buildings, or separate areas of buildings, constructed in accordance with Chapter 7 of the Standard for the Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58, and used exclusively to house industrial processes, research and experimental laboratories, or equipment or processing having similar hazards.

2.6 Acceptable Piping Materials and Joining Methods.

2.6.1 General:

a. Material Application: Materials and components conforming to nationally recognized standards or specifications listed herein and/or acceptable to the authority having jurisdiction may be used for appropriate applications, as prescribed and limited by this Code.

b. Used Materials: Pipe, fittings, valves or other materials shall not be used again unless they are free of foreign materials and have been ascertained to be adequate for the service intended.

c. Other Materials: Material not covered by the standards specifications listed herein shall be investigated and tested to determine that it is safe and suitable for the proposed service, and, in addition, shall be recommended for that service by the manufacturer and shall be acceptable to the authority having jurisdiction.

2.6.2 Metallic Pipe:

a. Cast-iron pipe shall not be used.

b. Steel and wrought-iron pipe shall be at least of standard weight (Schedule 40) and shall comply with one of the following standards:

1. The Standard for Welded and Seamless Wrought-Steel Pipe, ANSI B36.10;
2. Specification for Black and Hot-Dipped, Zinc-Coated Welded and Seamless Steel Pipe, ASTM A53;
3. Specification for Seamless Carbon Steel Pipe for High-Temperature Service, ASTM A106; or
4. Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, ASTM A120.

c. Nodular (ductile) iron pipe shall comply with one of the following standards:

1. The Standard for Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Gas, ANSI A21.52; or
2. Specification for Gray Iron and Ductile Iron Pressure Pipe, ASTM A377.

Such pipe shall be not less than 3-inch size, shall not be welded and shall be used only underground outside building foundation boundaries, or aboveground, provided that joints are properly restrained against movement and separation.

d. Copper and brass pipe shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet of gas. This is equivalent to a trace as determined by the following applicable standard: Test for Hydrogen Sulfide and Mercaptan Sulfur in Natural Gas (Cadmium Sulfate-Iodometric Titration Method), ANSI/ASTM D2385, or Test for Hydrogen Sulfide in Liquefied Petroleum (LP) Gases (Lead Acetate Method), ANSI/ASTM D2420.

Threaded copper, brass or aluminum alloy pipe in iron pipe sizes may be used with gases not corrosive to such material.

e. Aluminum alloy pipe shall comply with the Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube, ASTM B241 (except that the use of alloy 5456 is prohibited), and shall be suitably marked at each end of each length indicating compliance. Aluminum alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster or insulation or is subject to repeated wettings by such liquids as water, detergents or sewage.

Aluminum alloy pipe shall not be used in exterior locations or underground.

2.6.3 **Metallic Tubing:** Seamless copper, aluminum alloy or steel tubing may be used with gases not corrosive to such material.

a. Steel tubing shall comply with the Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines, ANSI/ASTM A539, or the Standard Specification for Copper Brazed Steel Tubing, ANSI/ASTM A254.

b. Copper tubing shall comply with standard Type K or L, of the Specification for Seamless Copper Water Tube, ASTM B88 or the Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service, ASTM B280.

Copper and brass tubing and fittings (except tin-lined copper tubing) shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet of gas. This is equivalent to a trace as determined by the following applicable standard: Test for Hydrogen Sulfide and Mercaptan Sulfur in Natural Gas (Cadmium Sulfate-Iodometric Titration Method), ANSI/ASTM D2385, or Test for Hydrogen Sulfide in Liquefied Petroleum (LP) Gases (Lead Acetate Method), ANSI/ASTM D2420.

c. Aluminum alloy tubing shall comply with the Specification for Aluminum-Alloy Drawn Seamless Tubes, ASTM B210, or the Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube, ASTM B241. Aluminum-alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster or insulation or is subject to repeated wettings by such liquids as water, detergents or sewage.

Aluminum-alloy tubing shall not be used in exterior locations or underground.

2.6.4 **Plastic Pipe, Tubing and Fittings:** Plastic pipe or tubing and compatible fittings shall be used outside underground only and shall conform with the Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings, ASTM D2513, or the Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings, ASTM D2517.

For use of plastic pipe, tubing and fittings in undiluted liquefied petroleum gas piping systems, see the Standard for Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58.

2.6.5 **Workmanship and Defects:** Gas pipe or tubing and fittings shall be clear and free from cutting burrs and defects in structure or threading and shall be thoroughly brushed, and chip and scale blown.

Defects in pipe or tubing or fittings shall not be repaired. When defective pipe, tubing or fittings are located in a system, the defective material shall be replaced.

2.6.6 **Protective Coating:** When in contact with material or atmosphere exerting a corrosive action, metallic piping and fittings coated with a corrosion-resistant material shall be used.

External or internal coatings or linings used on piping or components shall not be considered as adding strength.

2.6.7 **Metallic Pipe Threads:**

a. **Specifications for Pipe Threads:** Metallic pipe and fitting threads shall be taper pipe threads and shall comply with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.

b. **Damaged Threads:** Pipe with threads which are stripped, chipped, corroded or otherwise damaged shall not be used. If a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used.

c. **Number of Threads:** Table I may be used as a guide for field threading of metallic pipe.

d. **Threaded Pipe Sizes:** Threaded pipe in sizes larger than 4 inch shall not be used unless acceptable to the authority having jurisdiction.

Table I

Specifications for Threading Metallic Pipe

Iron Pipe Size (Inches)	Approximate Length of Threaded Portion (Inches)	Approximate No. of Threads to be Cut
½	¾	10
¾	¾	10
1	⅞	10
1¼	1	11
1½	1	11
2	1	11
2½	1½	12
3	1½	12
4	1⅝	13

2.6.8 **Metallic Piping Joints and Fittings:** The type of piping joint used shall be suitable for the pressure-temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue or to the weight of the pipe and its contents.

a. **Pipe Joints:** Pipe joints shall be threaded, flanged or welded, and nonferrous pipe may also be brazed with materials having a melting point in excess of 1,000 F. Brazing alloys shall not contain phosphorous.

Threaded joints shall not be used in annealed, tempered aluminum pipe.

b. **Tubing Joints:** Tubing joints shall either be made with approved gas tubing fittings or be brazed with a material having a melting point in excess of 1,000 F. Brazing alloys shall not contain phosphorous. Metallic ball sleeve compression type tubing fittings shall not be used for this purpose.

c. **Flared Joints:** Flared joints shall be used only in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is suitable for the conditions and where adequate provisions are made in the design to prevent separation of the joints.

d. **Couplings and Proprietary Joints:** Approved couplings and proprietary type joints may be used within the manufacturer's pressure-temperature recommendations, provided adequate provision is made to prevent separation of the joint due to vibration, fatigue and thermal expansion or contraction.

e. **Metallic Fittings:** Metallic fittings (except valves, strainers or filters) shall be steel, brass or malleable and cast iron or ductile iron when used with steel or wrought-iron pipe; shall be copper or brass when used with copper or brass pipe; and shall be aluminum alloy when used with aluminum alloy pipe.

1. When approved by the authority having jurisdiction, special fittings, such as saddle tees and gland-type compression couplings, may be used to connect steel or wrought-iron pipe if adequately braced so that neither the gas pressure nor external physical damage will force the joint apart.
2. Cast-iron fittings (including valves, strainers and filters) in sizes 6 inches and larger may be used to connect steel and wrought-iron pipe when approved by the authority having jurisdiction.
3. Cast-iron fittings in sizes 4 inches and larger shall not be used indoors unless approved by the authority having jurisdiction.
4. Cast-iron fittings and zinc-aluminum valves and fittings shall not be used in systems containing flammable gas-air mixtures.
5. Cast-iron flanges may be used.
6. Fittings in copper or brass piping systems, if exposed to soil, shall be made of bronze, copper or brass containing not less than 80 percent copper.
7. Approved flared, flareless or compression (other than metallic ball sleeve) type tubing fittings may be used provided they meet the manufacturer's pressure-temperature recommendations for the fittings and the service conditions anticipated, such as vibration, fatigue and thermal expansion or contraction.

f. **Bushings:** Cast-iron or plastic bushings, orange-peel bull plugs, orange-peel swages and fish tails shall not be used.

g. **Joint Compounds:** Joint compounds (pipe dope) shall be resistant to the action of liquefied petroleum gas or to any other chemical constituents of the gases to be conducted through the piping.

2.6.9 Plastic Piping Joints and Fittings: Plastic pipe, tubing and fittings shall be joined by either the solvent cement method, adhesive method, heat-fusion method, or by means of compression couplings or flanges. The joining method used shall be compatible with the materials being joined and the recommendations of the manufacturer. The following shall be observed when making such joints:

a. Plastic pipe or tubing shall not be threaded.

b. The joint shall be designed and installed so that the longitudinal pull-out resistance of the joint will be at least equal to the tensile strength of the plastic piping material.

c. Solvent cement joints, adhesive joints and heat-fusion joints shall be made in accordance with qualified procedures which have been established and proven by test to produce gastight joints at least as strong as the pipe or tubing being joined.

d. Solvent cement or heat-fusion joints shall not be made between different kinds of plastics.

e. Heat-fusion or mechanical joints shall be used when joining polyethylene pipe, tubing or fittings.

f. Flanges or special joints may be used providing they are properly qualified and utilized.

g. When compression type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting, and the stiffener shall be flush with the end of the pipe or tubing and extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. A split tubular stiffener shall not be used.

h. For plastic piping joints and fittings for use in liquefied petroleum gas piping systems, see the Standard for the Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58.

2.6.10 **Flanges:** All flanges shall comply with nationally recognized standards and specifications as listed in Appendix A. The pressure-temperature ratings shall equal or exceed that required by the application.

a. **Flange Facings:** Standard facings are suitable for use under this Code. When 150-pound steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed.

b. **Lapped Flanges:** Lapped flanges may be used only aboveground or in exposed locations accessible for inspection.

2.6.11 **Flange Gaskets:** Material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system, and the chemical constituents of the gas being conducted, without change to its chemical and physical properties. The effects of fire exposure to the joint shall be considered in choosing material.

a. Acceptable materials include:
  1. Metal or metal-jacketed asbestos (plain or corrugated);
  2. Asbestos; and
  3. Aluminum "O" rings and spiral wound metal gaskets.

b. When a flanged joint is opened, the gasket shall be replaced.

c. Full-face gaskets shall be used with all bronze and cast-iron flanges.

2.7 Gas Meters.

2.7.1 **Capacity:** Gas meters shall be properly selected for the maximum expected pressure and permissible pressure drop.

2.7.2 **Location:**

a. Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement or necessary maintenance.

b. Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway, under a fire escape, in public passages, halls, coal bins, or where they will be subject to excessive corrosion or vibration.

c. Gas meters shall be located at least 3 feet from sources of ignition.

d. Gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in temperature. Meter manufacturers shall furnish information regarding safe temperature limits.

2.7.3 **Supports:** Gas meters shall be securely supported or connected to rigid piping so as not to exert a strain on the meters. When flexible connectors are used to connect a gas meter to downstream piping at mobile homes in mobile home parks, the meter shall be supported by a post or bracket placed in a firm footing or other means providing equivalent support.

2.7.4 **Meter Protection:** Meters shall be protected against overpressure, backpressure and vacuum, if necessary.

2.7.5 **Identification:** Gas piping at multiple meter installations shall be plainly marked by a metal tag or other permanent means attached by the installing agency, designating the building or the part of the building being supplied.

2.8 Gas Pressure Regulators.

2.8.1 **When Required:** When the gas supply pressure is higher than that at which the branch supply line or gas utilization equipment is designed to operate or varies beyond design pressure limits, a line gas pressure regulator or gas equipment pressure regulator, as applicable, shall be installed.

2.8.2 **Location:** The gas pressure regulator location shall be such that the connections are readily accessible for servicing.

2.8.3 **Regulator Protection:** Pressure regulators shall be protected against physical damage.

2.8.4 **Venting:**

a. **Line Gas Pressure Regulators, Including Second Stage LP-Gas Regulators:**

1. An adequately sized independent vent to the outside of the building shall be provided when the location of a regulator is such that a ruptured diaphragm will cause a hazard. When there is more than one regulator at a location, each regulator shall have a separate vent to the outside. See 2.9.7 for properly locating the vent.
2. The vent shall be designed to prevent the entry of water, insects or other foreign materials that could cause blockage.
3. At locations where regulators might be submerged during floods, a special anti-flood type breather vent fitting

shall be installed, or the vent line shall be extended above the height of the expected flood waters.

4. A regulator shall not be vented to the gas equipment flue or exhaust system.

b. **Gas Appliance Pressure Regulators:** For venting of gas appliance pressure regulators, see 5.1.18.

2.8.5 **Bypass Piping:** Suitably valved and regulated bypasses may be placed around gas line pressure regulators where continuity of service is imperative.

2.8.6 **Identification:** Line pressure regulators at multiple regulator installations shall be plainly marked by a metal tag or other permanent means designating the building or the part of the building being supplied.

2.8.7 **Second Stage LP-Gas Regulators:** Second stage regulators on undiluted liquefied petroleum gas piping systems shall comply with the Standard for Pressure Regulating Valves for LP-Gas, ANSI/UL 144, and shall be installed in accordance with the Standard for Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58.

2.9 Overpressure Protection Devices.

2.9.1 **General:** Overpressure protection devices shall be provided to prevent the pressure in the piping system from exceeding that value which would cause unsafe operation of any connected and properly adjusted gas utilization equipment. (See 2.9.5.)

a. The requirements of this section shall be met and a piping system deemed to have adequate overpressure protection when there are two acceptable devices (a service or line pressure regulator plus one other device), each limiting the pressure to a value that does not exceed the maximum working pressure of the downstream system, both of which must fail simultaneously in order to overpressure the downstream system. The pressure regulating, limiting and relieving devices shall be properly maintained and inspection procedures shall be devised or suitable instrumentation installed to detect failures or malfunctions of such devices and replacements or repairs shall be promptly made.

b. No pressure relieving or limiting device is required if the gas does not contain materials that could seriously interfere with the operation of the service or line pressure regulator and if the service or line pressure regulator has all of the following design features or characteristics:

1. Pipe connections to the service or line regulator do not exceed 2 inches nominal diameter;
2. It is self-contained with no external static or control piping;
3. It has a single port valve with an orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet;
4. The valve seat is made of resilient material designed to withstand abrasion of the gas, impurities in the gas and cutting by the valve and to resist permanent deformation when it is pressed against the valve port; and
5. It is capable, under normal operating conditions, of regulating the downstream pressure within the necessary limits of accuracy and of limiting the discharge pressure under no-flow conditions to not more than 150 percent of the discharge pressure maintained under flow conditions.

2.9.2 Devices: Any of the following pressure relieving or pressure limiting devices may be used:

a. Spring loaded relief device.

b. Pilot loaded backpressure regulator used as a relief valve so designed that failure of the pilot system or external control piping will cause the regulator relief valve to open.

c. A monitoring regulator installed in series with the service or line pressure regulator.

d. A series regulator installed upstream from the service or line regulator and set to continuously limit the pressure on the inlet of the service or line regulator to the maximum working pressure of the downstream piping system.

e. An automatic shutoff device installed in series with the service or line pressure regulator and set to shut off when the pressure on the downstream piping system reaches the maximum working pressure or some other predetermined pressure less than the maximum working pressure. This device shall be designed so that it will remain closed until manually reset.

f. A liquid seal relief device that can be set to open accurately and consistently at the desired pressure.

The above devices may be installed as an integral part of the service or line pressure regulator or as separate units. If separate pressure relieving or pressure limiting devices are installed, they shall comply with 2.9.3 through 2.9.8.

2.9.3 **Construction and Installation:** All pressure relief or pressure limiting devices shall:

a. Be constructed of materials so that the operation of the device will not normally be impaired by corrosion of external parts by the atmosphere or of internal parts by the gas.

b. Be designed and installed so they can be readily operated to determine if the valve is free. The devices shall also be designed and installed so they can be tested to determine the pressure at which they will operate and examined for leakage when in the closed position.

2.9.4 **External Control Piping:** External control piping shall be reasonably protected from falling objects, excavations or other causes of damage and shall be designed and installed so that damage to any control piping shall not render both the regulator and the overpressure protective device inoperative.

2.9.5 **Setting:** Each pressure limiting or pressure relieving device shall be set so that the pressure shall not exceed a safe level beyond the maximum allowable working pressure for the piping and appliances connected.

2.9.6 **Unauthorized Operation:** Precautions shall be taken to prevent unauthorized operation of any shutoff valve which will make a pressure relief valve or pressure limiting device inoperative. Acceptable methods for complying with this provision are:

a. Lock the valve in the open position. Instruct authorized personnel of the importance of leaving the shutoff valve open and of being present while the shutoff valve is closed so that it can be locked in the open position before leaving the premises.

b. Install duplicate relief valves, each having adequate capacity to protect the system, and arrange the isolating valves or 3-way valve so that only one safety device can be rendered inoperative at a time.

2.9.7 **Vents:** The discharge stacks, vents or outlet parts of all pressure relief and pressure limiting devices shall be located so that gas is discharged into the atmosphere without undue hazard. Discharge stacks or vents shall be designed to prevent the entry of water, insects or other foreign material that could cause blockage. The discharge stack or vent line shall be at least the same size as the outlet of the pressure relieving device.

2.9.8 **Size of Fittings, Pipe and Openings:** The openings, pipe and fittings located between the system to be protected and the pressure relieving device shall be of adequate size to prevent hammering of the valve and to prevent impairment of relief capacity.

2.10 Back Pressure Protection.

2.10.1 **When to Install:** When the design of utilization equipment connected is such that air, oxygen or stand-by gases may be forced into the gas supply system, suitable protective devices shall be installed as close to the utilization equipment as practical. Gas and air combustion mixers incorporating double diaphragm "zero" or "atmosphere" governors or regulators require no further protection unless connected directly to compressed air or oxygen at pressures of 5 psig or more.

2.10.2 **Suitable Devices:** Suitable protective devices include but are not limited to the following:

a. Check valves;

b. Three-way valves (of the type that completely closes one side before starting to open the other side);

c. Reverse flow indicators controlling positive shutoff valves; and

d. Normally closed air-actuated positive-shutoff pressure regulators.

2.11 Low Pressure Protection.

A suitable protective device shall be installed between the meter and the gas utilization equipment if the operation of the equipment is such (i.e., gas compressors) that it may produce a vacuum or a dangerous reduction in gas pressure at the meter. Such devices include, but are not limited to mechanical, diaphragm-operated or electrically operated low-pressure shutoff valves.

2.12 Shutoff Valves.

Shutoff valves shall be approved and shall be selected giving consideration to pressure drop, service involved, emergency use and reliability of operation.

2.13 Expansion and Flexibility.

2.13.1 Design: Piping systems shall be designed to have sufficient flexibility to prevent thermal expansion or contraction from causing excessive stresses in the piping material, excessive bending or loads at joints, or undesirable forces or moments at points of connections to equipment and at anchorage or guide points. Formal calculations or model tests shall be required only where reasonable doubt exists as to the adequate flexibility of the system.

Flexibility shall be provided by the use of bends, loops, offsets or couplings of the slip type. Provision shall be made to absorb thermal changes by the use of expansion joints of the bellows type, or by the use of "ball" or "swivel" joints. Expansion joints of the slip type shall not be used inside buildings or for thermal expansion. If expansion joints are used, anchors or ties of sufficient strength and rigidity shall be installed to provide for end forces due to fluid pressure and other causes.

Pipe alignment guides shall be used with expansion joints according to the recommended practice of the joint manufacturer.

2.13.2 Special Local Conditions: Where local conditions include earthquake, tornado, unstable ground or flood hazards, special consideration shall be given to increased strength and flexibility of piping supports and connections.

PART 3

GAS PIPING INSTALLATION

3.1 Piping Underground.

3.1.1 Clearances: Underground gas piping shall be installed with enough clearance from any other underground structure to avoid contact therewith, to allow proper maintenance and to protect against damage that might result from proximity to other structures. In addition, underground plastic piping shall be installed with sufficient clearance, or shall be insulated, from any source of heat so as to prevent the heat from impairing the serviceability of the pipe.

3.1.2 Protection Against Damage: Where soil conditions are unstable and settling of piping or foundation walls or heavy vehicular traffic may occur, adequate measures shall be provided to prevent excessive stressing of the piping. Piping shall be buried a sufficient depth or covered in a manner so as to protect the piping from physical damage.

Consideration should be given to protecting the piping from physical damage when it passes through flower beds, shrub beds and other such cultivated areas.

a. **Cover Requirements:** Underground piping systems shall be installed with at least 18 inches of cover. The cover may be reduced to 12 inches if external damage to the pipe is not likely to result. If a minimum of 12 inches of cover cannot be maintained, the pipe shall be installed in conduit or bridged (shielded).

b. **Trenches:** The trench shall be graded so that the pipe has a firm, substantially continuous bearing on the bottom of the trench.

c. **Backfilling:** Where flooding of the trench is done to consolidate the backfill, care shall be exercised to see that the pipe is not floated from its firm bearing on the trench bottom.

3.1.3 Protection Against Corrosion: Gas piping in contact with earth, or other material which may corrode the piping, shall be protected against corrosion in an approved manner. When dissimilar metals are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders.

Uncoated threaded or socket welded joints shall not be used in piping in contact with soil or where internal or external crevice corrosion may occur.

3.1.4 Protection Against Freezing: Where the formation of hydrates or ice is a problem, piping shall be protected against freezing.

NOTE: The gas supplier may be consulted for recommendations.

3.1.5 Connection of Plastic Piping: Connections between metallic and plastic piping shall be made only outside, underground and with approved transition fittings.

3.1.6 Piping Through Foundation Wall: Underground piping, when installed below grade through the outer foundation or basement wall of a building, shall be encased in a protective pipe. The annular space between the gas piping and the sleeve shall be sealed at the foundation or basement wall to prevent entry of gas or water.

3.1.7 Piping Underground Beneath Buildings: When the installation of gas piping underground beneath buildings is unavoidable, the piping shall be encased in an approved conduit designed to withstand the superimposed loads. The conduit shall extend into a normally usable and accessible portion of the building and, at the point where the conduit terminates in the building, the space between the conduit and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. If the end sealing is of a type that will retain the full pressure of the pipe, the conduit shall be designed for the same pressure as the pipe. The conduit shall extend at least 4 inches outside the building, be vented above grade to the outside and be installed so as to prevent the entrance of water and insects.

3.2 Aboveground Piping Outside.

Piping installed aboveground shall be securely supported and located where it will be protected from physical damage. (Also see 3.1.4.) When passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material. When piping is encased in a protective pipe sleeve, the annular space between the gas piping and the sleeve shall be sealed at the wall to prevent the entry of water, insects or rodents.

3.3 Piping in Buildings.

3.3.1 Building Structure:

a. The installation of gas piping shall not cause structural stresses within building components to exceed allowable design limits.

b. Before any beams or joists are cut or notched, permission shall be obtained from the authority having jurisdiction.

3.3.2 Other Than Dry Gas: Drips, sloping, protection from freezing, and branch pipe connections, as provided for in 3.1.4, 3.3.3, 3.7.1 and 3.9-a, shall apply only when other than dry gas is distributed and climatic conditions make such provisions necessary.

3.3.3 Gas Piping to be Sloped: Piping for other than dry gas conditions shall be sloped not less than ¼ inch in 15 feet to prevent traps. Horizontal lines shall slope upward to risers and from the risers to the meter, or service regulator when a meter is not provided, or to the equipment.

3.3.4 Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces, whether or not such spaces are used as a plenum. Valves shall not be located in such spaces.

3.3.5 Prohibited Locations: Gas piping inside any building shall not be run in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb waiter or elevator shaft. This provision shall not apply to ducts used to provide combustion and ventilation air in accordance with 5.3 or to above-ceiling spaces as covered in 3.3.4.

3.3.6 Hangers, Supports and Anchors:

a. Piping shall be supported in a substantial and workmanlike manner with pipe hooks, metal pipe straps, bands, brackets or hangers suitable for the size of piping, of adequate strength and quality, and located at proper intervals so as to prevent or damp out excessive vibration. Piping shall be anchored sufficiently to prevent undue strains on connected equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of Standard Practice for Pipe Hangers and Supports—Materials, Design and Manufacture, ANSI/MSS SP-58.

b. Spacings of supports in gas piping installations shall not be greater than shown in Table II.

c. Supports, hangers and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. Suitable spring hangers, sway bracing, etc., shall be provided where necessary. All parts of the supporting equipment shall be designed and installed so they will not be disengaged by movement of the supported piping.

3.3.7 Removal of Pipe: If piping containing gas is to be removed, the line shall be first disconnected from all sources of gas and then thoroughly purged with air, water or with inert gas before any cutting or welding is done. (See 4.3.)

Table II

Support of Piping

Steel Pipe, Nominal Size of Pipe (Inches)	Spacing of Supports (Feet)	Nominal Size of Tubing (Inch O.D.)	Spacing of Supports (Feet)
½	6	½	4
¾ or 1	8	⅝ or ¾	6
1¼ or larger (horizontal)	10	⅞ or 1	8
1¼ or larger (vertical)	every floor level		

3.4 Concealed Piping in Buildings.

3.4.1 General: Gas piping may be installed in concealed locations in accordance with this section.

3.4.2 Piping in Partitions: Concealed gas piping shall not be located in solid partitions. Tubing shall not be run inside hollow walls or partitions unless protected against physical damage. This provision does not apply to tubing which passes through walls or partitions.

3.4.3 Piping in Floors:

a. Except as provided in "b," gas piping in solid floors such as concrete shall be laid in channels in the floor suitably covered to permit access to the piping with a minimum of damage to the building. When piping in floor channels may be exposed to excessive moisture or corrosive substances, it shall be suitably protected.

b. In other than industrial occupancies and when approved by the authority having jurisdiction, gas piping may be embedded in concrete floor slabs constructed with portland cement. Piping shall be surrounded with a minimum of 1½ inches of concrete and shall not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. All piping, fittings and risers shall be protected against corrosion in accordance with 2.6.6. Piping shall not be embedded in concrete slabs containing quickset additives or cinder aggregate.

3.4.4 Connections in Original Installations: When installing gas piping which is to be concealed, unions, tubing fittings, running threads, right and left couplings, bushings, and swing joints made by combinations of fittings shall not be used.

3.4.5 Reconnections: When necessary to insert fittings in gas pipe which has been installed in a concealed location, the pipe may be reconnected by welding, flanges, or the use of a ground joint union with the nut center-punched to prevent loosening by vibration. Reconnection of tubing in a concealed location is prohibited.

3.5 Piping in Vertical Chases.

3.5.1 Pressure Reduction: If pressure reduction is needed in branch connections for compliance with 2.5.1, such reduction shall take place either inside the chase or immediately adjacent to the outside wall of the chase. Regulator venting and downstream overpressure protection shall comply with 2.8.4 and 2.9. The regulator shall be accessible for service and repair.

a. Regulators equipped with a vent limiting means may be vented into the chase.

b. Regulators not equipped with a vent limiting means shall be vented directly to the outdoors or to a point within the top one foot of the chase.

3.5.2 Construction: Chase construction shall comply with local building codes with respect to fire resistance and protection of horizontal and vertical openings.

3.5.3 Ventilation: A chase shall be ventilated to the outdoors and only at the top. The opening(s) shall have a minimum free area (in square inches) equal to the product of one-half of the maximum pressure in the piping (in psig) times the largest nominal diameter of that piping (in inches), or the cross-sectional area of the chase, whichever is smaller. When more than one fuel gas piping system is present, the free area for each system shall be calculated and the largest area used.

> NOTE: Only vertical chases are recognized by the coverage. It is believed that welded joints for a horizontal gas line would be preferable to a horizontal chase.

3.6 Gas Pipe Turns.

Changes in direction of gas pipe may be made by the use of fittings, factory bends or field bends.

3.6.1 Metallic Pipe:

a. Bends shall be made only with bending equipment and procedures especially intended for that purpose.

b. All bends shall be smooth and free from buckling, cracks or other evidence of mechanical damage.

c. The longitudinal weld of the pipe shall be near the neutral axis of the bend.

d. Pipe shall not be bent through an arc of more than 90 degrees.

e. The inside radius of a bend shall be not less than 6 times the outside diameter of the pipe.

3.6.2 Plastic Pipe:

a. Plastic pipe may be bent provided that the pipe is not damaged and the internal diameter of the pipe is not effectively reduced.

b. The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe.

c. When the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used.

3.6.3 **Mitered Bends:** Mitered bends are permitted subject to the following limitations:

a. Miters shall not be used in systems having a design pressure greater than 50 psig. Deflections caused by misalignments up to 3 degrees are not considered as miters.

b. The total deflection angle at each miter shall not exceed 90 degrees.

c. Care shall be taken in making mitered joints to provide proper root opening and alignment and full weld penetration.

3.6.4 **Elbows:** Factory made welding elbows or transverse segments cut therefrom may be used for changes in direction provided that the arc length measured along the crotch is at least one inch in pipe sizes 2 inches and larger.

3.7 Drips and Sediment Traps.

3.7.1 **Provide Drips Where Necessary:** A drip shall be provided at any point in the line of pipe where condensate may collect. When condensation is excessive, a drip should be provided at the outlet of the meter. This drip should be so installed as to constitute a trap wherein an accumulation of condensate will shut off the flow of gas before it will run back into the meter.

3.7.2 **Location of Drips:** All drips shall be installed only in such location that they will be readily accessible to permit cleaning or emptying. A drip shall not be located where the condensate is likely to freeze.

3.7.3 **Sediment Traps:** See 5.5.6.

3.8 Outlets.

3.8.1 **Location and Installation:**

a. The outlet fittings or piping shall be securely fastened in place.

b. Outlets shall not be located behind doors.

c. Outlets shall be located far enough from floors, walls, patios, slabs and ceilings to permit the use of proper wrenches without straining, bending or damaging the piping.

d. The unthreaded portion of gas piping outlets shall extend not less than one inch through finished ceilings or indoor or outdoor walls.

e. The unthreaded portion of gas piping outlets shall extend not less than 2 inches above the surface of floors or outdoor patios or slabs.

f. The provisions of 3.8.1-d and -e do not apply to listed quick-disconnect devices of the flush-mounted type. Such devices shall be installed in accordance with the manufacturer's installation instructions.

3.8.2 Cap All Outlets:

a. Each outlet, including a valve or cock outlet, shall be securely closed gastight with a threaded plug or cap immediately after installation and shall be left closed until the gas utilization equipment is connected thereto. Likewise, when the equipment is disconnected from an outlet and the outlet is not to be used again immediately, it shall be securely closed gastight. The outlet shall not be closed with tin caps, wooden plugs, corks, or by other improvised methods.

b. The above provision does not prohibit the normal use of a listed quick-disconnect device.

3.9 Branch Pipe Connection.

a. Except on undiluted liquefied petroleum gas supply systems, all branch outlet pipes shall be taken from the top or sides of horizontal lines and not from the bottom.

b. When a branch outlet is placed on a main supply line before it is known what size pipe will be connected to it, the outlet shall be of the same size as the line which supplies it.

3.10 Manual Gas Shutoff Valves (Also see 5.5.4).

3.10.1 Valves at Regulators: An accessible gas shutoff valve shall be provided upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

3.10.2 Valves Controlling Multiple Systems:

a. **Accessibility of Gas Valves:** Main gas shutoff valves controlling several gas piping systems shall be readily accessible for operation and installed so as to be protected from physical damage. They shall be plainly marked with a metal tag attached by the installing agency so that the gas piping systems supplied through them can be readily identified.

b. Shutoff Valves for Multiple House Lines: In multiple tenant buildings supplied through a master meter, or one service regulator when a meter is not provided, or where meters or service regulators are not readily accessible from the equipment location, an individual shutoff valve for each apartment or tenant line shall be provided at a convenient point of general accessibility.

In a common system serving a number of individual buildings, shutoff valves shall be installed at each building.

3.10.3 Emergency Shutoff Valves: An exterior shutoff valve to permit turning off the gas supply to each building in an emergency shall be provided. The emergency shutoff valves shall be plainly marked as such and their locations posted at appropriate points.

3.11 Prohibited Devices.

No device shall be placed inside the gas piping or fittings that will reduce the cross-sectional area or otherwise obstruct the free flow of gas, except when proper allowance in the piping system design has been made for such a device and when approved by the authority having jurisdiction.

3.12 Systems Containing Gas-Air Mixtures Outside the Flammable Range.

When gas-air mixing machines are employed to produce mixtures above or below the flammable range, they shall be provided with suitable stops to prevent adjustment of the mixture to within or approaching the flammable range.

3.13 Systems Containing Flammable Gas-Air Mixtures.

3.13.1 Required Components: A central premix system with a flammable mixture in the blower or compressor shall consist of the following components:

a. Gas-mixing machine in the form of an automatic gas-air proportioning device combined with a downstream blower or compressor.

b. Flammable mixture piping, minimum Schedule 40 NPS.

c. Automatic firecheck(s).

d. Safety blowout(s) or backfire preventers for systems utilizing flammable mixture lines above 2½ inches nominal pipe size or the equivalent.

3.13.2 **Optional Components:** The following components may also be utilized in any type central premix system:

a. Flowmeter(s).

b. Flame arrester(s).

3.13.3 **Additional Requirements:** Gas-mixing machines shall have nonsparking blowers and shall be so constructed that a flashback will not rupture machine casings.

3.13.4 **Limitations:** A mixing blower system shall be limited to applications with minimum practical lengths of mixture piping, limited to a maximum mixture pressure of 10 inches water column, and limited to gases containing no more than 10 percent hydrogen.

The blower shall be equipped with a gas-control valve at its air entrance so arranged that gas is admitted to the air stream, entering the blower in proper proportions for correct combustion by the type of burners employed; the said gas-control valve being of either the zero governor or mechanical ratio valve type which controls the gas and air adjustment simultaneously. No valves or other obstructions shall be installed between the blower discharge and the burner or burners.

NOTE: The mixing blower is acknowledged as a special case because of its inability to tolerate control valves or comparable restrictions between mixing blower and burner(s). With these limitations, mixing blower installations are not required to utilize safety blowouts, backfire preventers, explosion heads, flame arresters or automatic firechecks which introduce pressure losses.

3.13.5 **Installation of Gas-Mixing Machines:**

a. The machine shall be located in a large, well-ventilated area or in a small detached building or cut-off room provided with room construction and explosion vents in accordance with the Guide for Explosion Venting, ANSI/NFPA 68. Such rooms or below-grade installations shall have adequate positive ventilation.

b. When gas-mixing machines are installed in well-ventilated areas, the type of electrical equipment shall be governed by the National Electrical Code, ANSI/NFPA 70, for general service conditions unless other hazards in the area prevail.

When gas-mixing machines are installed in small detached buildings or cut-off rooms, the electrical equipment and wiring shall be installed in accordance with the National Electrical Code, ANSI/NFPA 70, for hazardous locations (Article 500, Sections 501-1 through 501-17, Class I, Division 2).

c. Air intakes for gas-mixing machines using compressors or blowers shall be taken from outdoors whenever practical.

d. Controls for gas-mixing machines shall include interlocks and a safety shutoff valve of the manual reset type in the gas supply connection to each machine arranged to automatically shut off the gas supply in the event of high or low gas pressure. Except for open burner installations only, this shall be interlocked so that the blower or compressor will stop operating following a gas supply failure. When a system employs pressure air, suitable means shall be provided to shut off the gas supply in the event of air failure.

NOTE: Additional interlocks may be necessary for safe operation of equipment supplied by the gas-mixing machine.

e. Centrifugal gas-mixing machines in parallel can cause troublesome downstream pulsation or equipment overload. Such systems shall be carefully reviewed by user and equipment manufacturer before installation and means or plans for minimizing these effects shall be prepared and utilized as required.

3.13.6 Use of Automatic Firechecks, Safety Blowouts or Backfire Preventers: Automatic firechecks and safety blowouts or backfire preventers shall be provided in piping systems distributing flammable air-gas mixtures from gas-mixing machines to protect the piping and the machines in event of flashback in accordance with the following recommendations:

a. Approved automatic firechecks shall be installed upstream as close as practicable to the burner inlets following the firecheck manufacturer's instructions.

NOTE 1: Two basic methods are generally used. One calls for a separate firecheck at each burner; the other a firecheck at each group of burners. The second method is generally more practical if a system consists of many closely spaced burners.

NOTE 2: An approved automatic firecheck shall be installed as near as practicable upstream from a flame arrester used for local protection where test burners or lighting torches are employed.

b. A separate manually operated gas valve shall be provided at each automatic firecheck for shutting off the flow of the gas-air mixture through the firecheck after a flashback has occurred. The valve shall be located upstream as close as practicable to the inlet of the automatic firecheck.

CAUTION: These valves shall not be reopened after a flashback has occurred until the firecheck has cooled sufficiently to prevent reignition of the flammable mixture and has been properly reset.

c. A safety blowout or backfiring preventer shall be provided in the mixture line near the outlet of each gas-mixing machine where the size of the piping is larger than 2½ inches NPS or equivalent, to protect the mixing equipment in the event of an explosion passing through an automatic firecheck. The manufacturer's instructions shall be followed when installing these devices, particularly after a disc has burst.

The discharge from the safety blowout or backfire preventer shall be located or shielded so that particles from the ruptured disc cannot be directed toward personnel. Whenever there are interconnected installations of gas-mixing machines with safety blowouts or backfire preventers, provision shall be made to keep the mixture from other machines from reaching any ruptured disc opening. Check valves shall not be used for this purpose.

d. Explosion heads (rupture disc) may be provided in large capacity premix systems to relieve excessive pressure in pipelines. They shall be located at and vented to a safe outdoor location. Provisions shall be provided for automatically shutting off the supply of gas-air mixture in the event of rupture.

3.14 Electrical Bonding and Grounding.

a. Each aboveground portion of a gas piping system upstream from the equipment shutoff valve shall be electrically continuous and bonded to any grounding electrode, as defined by the National Electrical Code, ANSI/NFPA 70.

b. Gas piping shall not be used as a grounding electrode.

3.15 Electrical Circuits.

Electrical circuits shall not utilize gas piping or components except that low-voltage (50 volts or less) control circuits, ignition circuits, and electronic flame detection device circuits may make use of piping or components for a part of an electric circuit.

3.16 Electrical Connections.

a. All electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of the National Electrical Code, ANSI/NFPA 70 (see 3.14).

b. Any essential safety control depending upon electric current as the operating medium shall be of a type which will shut off (fail safe) the flow of gas in the event of current failure.

PART 4

INSPECTION, TESTING AND PURGING

4.1 Pressure Testing and Inspection.

4.1.1 General:

a. Prior to acceptance and initial operation, all piping installations shall be inspected and tested to determine that the materials, design, fabrication and installation practices comply with the requirements of this Code.

b. Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly or pressure tests as appropriate. Supplementary types of nondestructive inspection techniques, such as magnetic-particle, radiographic, ultrasonic, etc., although desirable, are not required unless specifically listed herein or in the engineering design.

c. In the event repairs or additions are made following the pressure test, the affected piping shall be tested, except that in the case of minor repairs or additions testing may be omitted when precautionary measures are taken to assure sound construction.

d. Because it is sometimes necessary to divide a piping system into test sections and install test heads, connecting piping, and other necessary appurtenances for testing, it is not required that the tie-in sections of pipe be pressure tested. Tie-in connections, however, shall be tested with soap solution after gas has been introduced and the pressure has been increased sufficiently to give some indications should leaks exist. (See caution following 4.1.5-b.)

e. The test procedure used shall be capable of disclosing all leaks in the section being tested and shall be selected after giving due consideration to the volumetric content of the section and to its location.

f. A piping system may be tested as a complete unit or in sections as the construction progresses. Under no circumstances shall a valve in a line be used as a bulkhead between gas in one section of the piping system and test medium in an adjacent section, unless two valves are installed in series with a valved "telltale" located between these valves. A valve shall not be subjected to the test pressure unless it can be determined that the valve, including the valve closing mechanism, is designed to safely withstand the test pressure.

g. Regulator and valve assemblies fabricated independently of the piping system in which they are to be installed may be tested with inert gas at the time of fabrication.

4.1.2 Test Medium:

a. Except as provided in 4.1.2-b, the test medium shall be air or inert gas (e.g., nitrogen, carbon dioxide). OXYGEN SHALL NEVER BE USED.

b. Fuel gas may be used in piping systems operating at pressures of ½ pound per square inch or less.

4.1.3 Test Preparation:

a. Whenever possible, pipe joints, including welds, shall be left uninsulated and exposed for examination during the test. If the pipe end joints have been previously tested in accordance with this Code, they may be insulated, covered or concealed.

b. Expansion joints shall be provided with temporary restraints, if required, for the additional thrust load under test.

c. Equipment which is not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test need not be tested.

d. When the piping system is connected to equipment or components designed for operating pressures of less than the test pressure, such equipment and their individual shutoff valves shall be isolated from the piping system by disconnecting them and capping the outlet(s).

e. When the piping system is connected to equipment or components designed for operating pressures equal to or greater than the test pressure, such equipment shall be isolated from the piping system by closing their individual manual shutoff valve(s).

f. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Prior to testing, the interior of the pipe shall be cleared of all foreign material.

4.1.4 Test Pressure:

a. Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record or indicate a pressure loss due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made.

b. The test pressure to be used shall be no less than 1½ times the proposed maximum working pressure, but not less than 3 psig, irrespective of design pressure. When the test pressure exceeds 125 psig, the test pressure shall not exceed a value which produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.

c. Systems for undiluted liquefied petroleum gases shall withstand the pressure test in accordance with "b" above, or, for systems operating at a pressure of ½ psig or less when appliances are connected to the piping system, shall withstand a pressure of not less than 10.0 inches nor more than 14.0 inches water column for a period of not less than 10 minutes without showing any drop in pressure. The source of pressure shall be isolated before the pressure tests are made.

d. Test duration shall be not less than one-half hour for each 500 cubic feet of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet or a system in a single-family dwelling, the test duration may be reduced to 10 minutes. For piping systems having a volume of more than 24,000 cubic feet, the duration of the test need not exceed 24 hours.

4.1.5 Detection of Leaks and Defects:

a. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gages shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

b. The leakage shall be located by means of an approved combustible gas detector, soap and water, or an equivalent nonflammable solution, as applicable. **Matches, candles, open flames, or other methods which could provide a source of ignition shall not be used.**

CAUTION: Since some leak test solutions, including soap and water, may cause corrosion or stress cracking, the piping shall be rinsed with water after testing, unless it has been determined the leak test solution is noncorrosive.

When leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested. (See 4.1.1-c.)

4.1.6 **Test Records:** Records shall be made of inspection and all tests performed. These records shall indicate which portions of the piping system conform to this Code or were pressure tested.

4.2 System and Equipment Check.

4.2.1 **Before Turning Gas On:** Before gas is introduced into a system of new gas piping, or back into an existing system after being shut off, the entire system shall be checked to determine that there are no open fittings or ends and that all manual valves on equipment are closed and all unused valves at outlets are closed and plugged or capped.

4.2.2 **Check for Leakage:** Immediately after turning on the gas, the piping system shall be checked to ascertain that no gas is escaping. (See Appendix D for suggested method.)

If leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made.

4.2.3 **Placing Equipment in Operation:** Gas utilization equipment may be placed in operation after the piping system has been tested and determined to be free of leakage and purged in accordance with 4.3.2.

4.3 Purging.

The processes of voiding a gas pipe line of fuel gas and replacing the fuel gas with air, or charging a gas pipe line that is full of air with fuel gas, require that a significant amount of combustible mixture not be developed within the pipe line or released within a confined space.

4.3.1 **Removal from Service:** When gas piping is to be opened for servicing, addition or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point, and the line pressure vented to the outdoors.

If this section exceeds the lengths shown in Table III, the remaining gas shall be displaced with an inert gas.

4.3.2 **Placing in Operation:** When piping full of air is placed in operation, the air in the piping shall be displaced with fuel gas, provided the piping does not exceed the length shown in Table IV. The air can be safely displaced with fuel gas provided that a moderately rapid and continuous flow of fuel gas is introduced at one end of the line and air is vented out at the other end. The fuel gas flow should be continued without interruption until the vented gas is free of air.

The point of discharge shall not be left unattended during purging. The vent shall then be closed.

If the piping exceeds the lengths shown in Table IV, the air in the piping shall be displaced with an inert gas, and the inert gas shall then be displaced with fuel gas.

4.3.3 Discharge of Purged Gases: The open end of piping systems being purged shall not discharge into confined spaces or areas where there are sources of ignition unless precautions are taken to perform this operation in a safe manner by ventilation of the space, control of purging rate, and elimination of all hazardous conditions.

4.3.4 Placing Equipment in Operation: After the piping has been placed in operation, all equipment shall be purged and then placed in operation, as necessary.

Table III

Length of Gas Line Requiring Purging for Servicing or Modification

Nominal Pipe Size, Inches	Min. Length of Piping Requiring Purging
2½	50 feet
3	30 feet
4	15 feet
6	10 feet
8 or larger	Any length

Table IV

Length of Piping Requiring Purging Before Placing in Operation

Nominal Pipe Size, Inches	Min. Length of Piping Requiring Purging
3	30 feet
4	15 feet
6	10 feet
8 or larger	Any length

PART 5

EQUIPMENT INSTALLATION

5.1 General.

5.1.1 Appliances, Accessories and Equipment To Be "Approved": Gas appliances, accessories, and gas utilization equipment shall be "Approved." "Approved" shall mean "acceptable to the authority having jurisdiction."

Acceptance of unlisted gas utilization equipment and accessories shall be on the basis of a sound engineering evaluation. In such cases, the equipment shall be safe and suitable for the proposed service and be recommended for the service by the manufacturer.

> NOTE: The National Fire Protection Association, the American National Standards Institute and the American Society of Mechanical Engineers do not approve, inspect or certify any installations, procedures, equipment or materials, nor do they approve or evaluate testing laboratories. In determining acceptability of installations or procedures, the authority having jurisdiction may base acceptance on compliance with NFPA, ANSI, ASME, or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices (see Part 10, Definitions) of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

5.1.2 Assignment and Coordination of Gas Equipment Design, Construction and Maintenance: Because industrial gas applications are so varied in nature, many agencies are jointly involved with their safe and satisfactory use. See Appendix B for suggested guidelines and check list.

5.1.3 Type of Gas (es): It shall be determined whether the gas utilization equipment has been designed for use with the gas to which it will be connected. No attempt shall be made to convert the equipment from the gas specified on the rating plate for use with a different gas without consulting the serving gas supplier or the equipment manufacturer for complete instructions.

5.1.4 Safety Shutoff Devices for Unlisted LP-Gas Equipment Used Indoors: Unlisted gas utilization equipment for use with undiluted liquefied petroleum gases and installed indoors, shall be equipped with safety shutoff devices of the complete shutoff type.

5.1.5 Use of Air or Oxygen Under Pressure: When air or oxygen under pressure is used in connection with the gas supply, effective means such as a backpressure regulator and relief valve shall be provided to prevent air or oxygen from passing back into the gas piping. The serving gas supplier shall be consulted for details. When oxygen is used, see the Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes, ANSI/NFPA 51.

5.1.6 Protection of Gas Equipment from Fumes or Gases Other than Products of Combustion: When corrosive or flammable process fumes are present, suitable means for their safe disposal shall be provided. Such fumes include, among others, carbon monoxide, hydrogen sulfide, ammonia, chlorine and halogenated hydrocarbons.

NOTE: Halogenated hydrocarbons are particularly injurious and corrosive after contact with flames or hot surfaces.

5.1.7 Building Structural Members:

a. Structural members of a building shall not pass through gas utilization equipment having an operating temperature in excess of 500 F.

b. Structural members passing through gas utilization equipment having an operating temperature of 500 F or less shall be of noncombustible material. Building columns, girders, beams or trusses shall not be included within equipment, unless appropriate insulation and ventilation are provided to avoid all deterioration in strength, and linear expansion of the building structure in either a vertical or horizontal direction.

c. Gas utilization equipment shall be furnished either with load distributing bases or with a sufficient number of adequate supports to prevent damage to either the building structure or equipment.

d. At the locations selected for installation of gas utilization equipment, the dynamic and static load carrying capacities of the building structure shall be checked to determine if they are adequate to carry the additional loads. The equipment shall be adequately supported and shall be connected to the piping so as not to exert undue stress on the connections.

5.1.8 **Flammable Vapors:** Gas appliances shall not be installed in any location where flammable vapors are likely to be present, unless the design, operation and installation are such to eliminate the probable ignition of the flammable vapors. Gas utilization equipment installed in compliance with 5.1.9, 5.1.10 and 5.1.11 shall be considered to comply with the intent of this provision.

5.1.9 **Installation in Residential Garages:**

a. Gas utilization equipment in residential garages shall be installed so that all burners and burner ignition devices are located not less than 18 inches above the floor.

b. Such equipment shall be located, or protected, so it is not subject to physical damage by a moving vehicle.

5.1.10 **Installation in Commercial Garages:**

a. **Parking Structures:** Gas utilization equipment may be installed in enclosed, basement and underground parking structures (see Part 10, Definitions) when there is no dispensing or transferring of liquefied petroleum gas or Class I or Class II flammable liquids (as defined in the Flammable and Combustible Liquids Code, ANSI/NFPA 30), provided all burners, burner flames and burner ignition devices are located not less than 18 inches above the floor, or the equipment is enclosed by a partition not less than 18 inches high, and provided continuous mechanical ventilation is supplied at a rate of not less than six air changes per hour. Gas utilization equipment shall be located or protected so it is not subject to physical damage by a moving vehicle.

Overhead heaters shall be installed at least 8 feet above the floor. Overhead radiant type heaters shall be located at a sufficient height to avoid overheating vehicles parked underneath.

For installations in parking structures which have facilities for dispensing fuel, see the Standard for Parking Structures, NFPA 88A.

b. **Repair Garages:** Gas utilization equipment may be installed in a repair garage (see Part 10, Definitions) when there is no dispensing or transferring of liquefied petroleum gas or Class I or II flammable liquids (as defined in the Flammable and Combustible Liquids Code, ANSI/NFPA 30), provided all burners, burner flames and burner ignition devices are located not less than 18 inches above the floor, and provided continuous mechanical ventilation is supplied at a rate of not less than 0.75 cubic foot per minute per square foot of floor area. For installations in below grade areas, an approved means shall be provided for introducing an equal amount of outdoor air. The equipment and the ventilation system shall be interlocked so the equipment will not operate unless the ventilation system is in operation. Gas utilization equipment shall be located or protected so it is not subject to physical damage by a moving vehicle.

Overhead heaters shall be installed at least 8 feet above the floor. Overhead radiant type heaters shall be located at a sufficient height to avoid overheating vehicles parked underneath.

For installations in repair garages which have facilities for dispensing fuel, see the Standard for Repair Garages, NFPA 88B.

5.1.11 **Installation in Aircraft Hangars:** Heaters in aircraft hangars shall be installed in accordance with the Standard on Aircraft Hangars, ANSI/NFPA 409.

5.1.12 **Gas Equipment Physical Protection:** When it is necessary to locate gas utilization equipment close to a passageway traveled by trucks or cranes, suitable guard rails or bumper plates shall be installed to protect the equipment from damage.

5.1.13 **Venting of Flue Gases:** Gas utilization equipment shall be vented in accordance with the provisions of Part 7, Venting of Equipment.

5.1.14 **Extra Device or Attachment:** No device or attachment shall be installed on any gas utilization equipment which may in any way impair the combustion of gas.

5.1.15 **Adequate Capacity of Piping:** When connecting additional gas utilization equipment to a gas piping system, the existing piping shall be checked to determine if it has adequate capacity (see 2.4). If inadequate, the existing system shall be enlarged as necessary or separate gas piping of adequate capacity shall be run from the point of delivery to the equipment.

5.1.16 **Avoid Strain on Gas Piping:** Gas utilization equipment shall be adequately supported and so connected to the piping as not to exert undue strain on the connections.

5.1.17 **Gas Appliance Pressure Regulators:** When the gas supply pressure is higher than that at which the gas utilization equipment is designed to operate or varies beyond the design pressure limits of the equipment, a gas appliance pressure regulator shall be installed.

5.1.18 Venting of Gas Appliance Pressure Regulators:

a. Gas appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, if the regulator vent is an integral part of the equipment, into the combustion chamber adjacent to a continuous pilot, unless constructed or equipped with a vent limiting means to limit the escape of gas from the vent opening in the event of diaphragm failure.

b. Vent limiting means shall be employed on listed gas appliance pressure regulators only.

c. In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent stoppage of it by insects and foreign matter.

d. Under no circumstances shall a regulator be vented to the gas utilization equipment flue or exhaust system.

e. In the case of vents entering the combustion chamber, the vent shall be located so the escaping gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the vent shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the vent piping shall be determined.

f. A vent line(s) from a gas appliance pressure regulator and a bleed line(s) from a diaphragm type valve shall not be connected to a common manifold terminating in a combustion chamber.

5.1.19 Bleed Lines for Diaphragm Type Valves:

a. Diaphragm type valves shall be equipped to convey bleed gas to the outside atmosphere or into the combustion chamber adjacent to a continuous pilot.

b. In the case of bleed lines leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent stoppage of it by insects and foreign matter.

c. Under no circumstances shall bleed lines terminate in the gas utilization equipment flue or exhaust system.

d. In the case of bleed lines entering the combustion chamber, the bleed line shall be located so the bleed gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the bleed line shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the bleed line piping shall be determined.

e. A bleed line(s) from a diaphragm type valve and a vent line(s) from a gas appliance pressure regulator shall not be connected to a common manifold terminating in a combustion chamber.

5.1.20 **Combination of Equipment:** Any combination of gas utilization equipment, attachments or devices used together in any manner shall comply with the standards which apply to the individual equipment.

5.1.21 **Installation Instructions:** The installing agency shall conform with the equipment manufacturer's specific recommendations in completing an installation that will provide satisfactory performance and serviceability. The installing agency shall also leave the manufacturer's installation, operating and maintenance instructions in a location on the premises where they will be readily available for reference and guidance of the authority having jurisdiction, servicemen and the owner or operator.

5.1.22 **Protection of Outdoor Equipment:** Gas utilization equipment not listed for outdoor installation but installed outdoors shall be provided with protection to the degree that the environment requires. Equipment listed for outdoor installation may be installed without protection in accordance with the provisions of their listing. (See 5.2.1.)

5.2 Accessibility and Clearance.

5.2.1 **Accessibility for Service:** All gas utilization equipment shall be located with respect to building construction and other equipment so as to permit access to the gas utilization equipment. Sufficient clearance shall be maintained to permit cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and, the proper functioning of explosion vents, if provided. For attic installation the passageway and servicing area adjacent to the equipment shall be floored.

5.2.2 **Clearance to Combustible Materials:** Gas utilization equipment and their vent connectors shall be installed with clearances from combustible material so their operation will not create a hazard to persons or property.

Minimum clearances between combustible walls and the back and sides of various conventional types of equipment and their vent connectors are specified in Part 6, Installation of Specific Equipment, and Part 7, Venting of Equipment. (Reference may also be made to the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, ANSI/NFPA 211.)

Equipment shall not be installed on carpeting, unless the equipment is listed for such installation.

5.3 Air for Combustion and Ventilation.

5.3.1 General:

a. The provisions of 5.3 apply to gas utilization equipment installed in buildings and which require air for combustion, ventilation and dilution of flue gases from within the building. They do not apply to (1) direct vent equipment which is constructed and installed so that all air for combustion is obtained from the outside atmosphere and all flue gases are discharged to the outside atmosphere, or (2) enclosed furnaces which incorporate an integral total enclosure and use only outside air for combustion and dilution of flue gases.

b. Equipment shall be installed in a location in which the facilities for ventilation permit satisfactory combustion of gas, proper venting and the maintenance of ambient temperature at safe limits under normal conditions of use. Equipment shall be located so as not to interfere with proper circulation of air. When normal infiltration does not provide the necessary air, outside air shall be introduced.

c. In addition to air needed for combustion, process air shall be provided as required for: cooling of equipment or material, controlling dew point, heating, drying, oxidation or dilution, safety exhaust, odor control, and air for compressors.

d. In addition to air needed for combustion, air shall be supplied for ventilation, including all air required for comfort and proper working conditions for personnel.

e. A draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment in such a manner as to prevent any difference in pressure between the hood or regulator and the combustion air supply.

f. While all forms of building construction cannot be covered in detail, air for combustion, ventilation and dilution of flue gases for gas utilization equipment vented by natural draft normally may be obtained by application of one of the methods covered in 5.3.3 and 5.3.4.

g. Air requirements for the operation of exhaust fans, kitchen ventilation systems, clothes dryers and fireplaces shall be considered in determining the adequacy of a space to provide combustion air requirements. See Appendix H for one method of determining adequate air for equipment operation.

5.3.2 **Equipment Located in Unconfined Spaces:** In unconfined spaces (see Part 10, Definitions) in buildings, infiltration may be adequate to provide air for combustion, ventilation and dilution of flue gases. However, in buildings of tight construction (for example, weather stripping, heavily insulated, caulked, vapor barrier, etc.), additional air may need to be provided using the methods described in 5.3.3-b or 5.3.4.

5.3.3 **Equipment Located in Confined Spaces:**

a. **All Air from Inside the Building:** The confined space shall be provided with two permanent openings communicating directly with an additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. The total input of all gas utilization equipment installed in the combined space shall be considered in making this determination. Each opening shall have a minimum free area of 1 square inch per 1,000 Btu per hour of the total input rating of all gas utilization equipment in the confined space, but not less than 100 square inches. One opening shall be within 12 inches of the top and one within 12 inches of the bottom of the enclosure. (See Figure 1.)

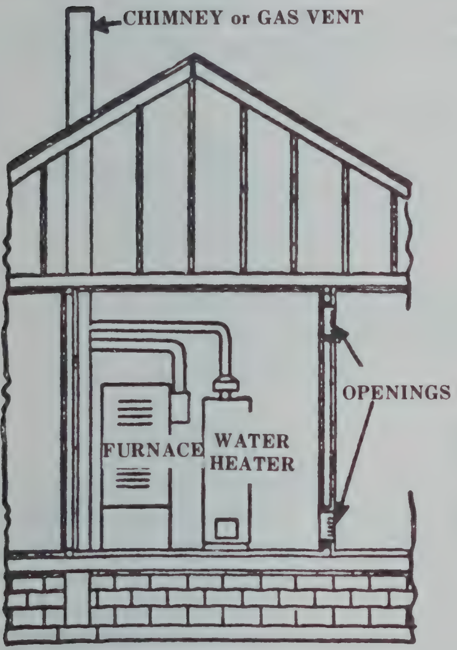
b. **All Air From Outdoors:** The confined space shall be provided with two permanent openings, one commencing within 12 inches of the top and one commencing within 12 inches of the bottom of the enclosure. The openings shall communicate directly, or by ducts, with the outdoors or spaces (crawl or attic) that freely communicate with the outdoors.

1. When directly communicating with the outdoors, each opening shall have a minimum free area of 1 square inch per 4,000 Btu per hour of total input rating of all equipment in the enclosure. (See Figure 2.)
2. When communicating with the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4,000 Btu per hour of total input rating of all

equipment in the enclosure. (See Figure 3.)

3. When communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 square inch per 2,000 Btu per hour of total input rating of all equipment in the enclosure. (See Figure 4.)

4. When ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect. The minimum dimension of rectangular air ducts shall be not less than 3 inches.



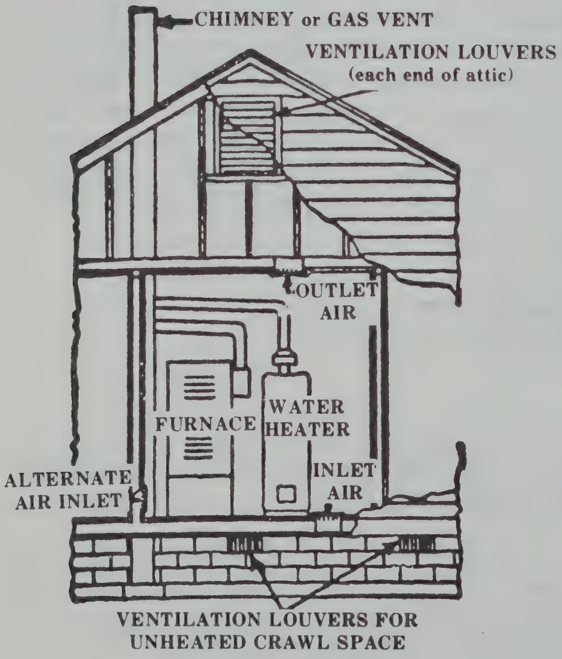
NOTE: Each opening shall have a free area of not less than one square inch per 1,000 Btu per hour of the total input rating of all equipment in the enclosure, but not less than 100 square inches.

Fig. 1. Equipment Located in Confined Spaces; All Air from Inside the Building. See 5.3.3-a.

5.3.4 Specially Engineered Installations: The requirements of 5.3.3 shall not necessarily govern when special engineering, approved by the authority having jurisdiction, provides an adequate supply of air for combustion, ventilation, and dilution of flue gases.

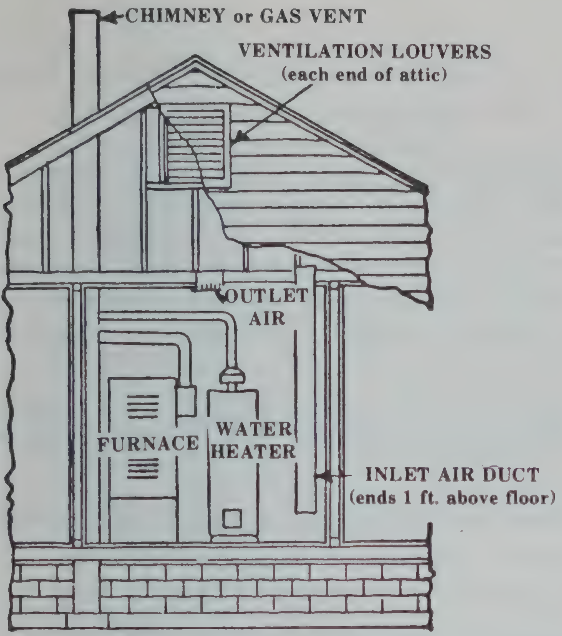
5.3.5 Louvers and Grilles: In calculating free area in 5.3.3, consideration shall be given to the blocking effect of louvers, grilles or screens protecting openings. Screens used shall not be smaller than ¼ inch mesh. If the free area through a design of louver or grille is known, it should be used in calculating the size opening required to provide the free area specified. If the design and free area is not known, it may be assumed that wood louvers will have 20-25 percent free area and metal louvers and grilles will have 60-75 percent free area. Louvers and grilles shall be fixed in the open position or interlocked with the equipment so that they are opened automatically during equipment operation.

5.3.6 Special Conditions Created by Mechanical Exhausting or Fireplaces: Operation of exhaust fans, ventilation systems, clothes dryers or fireplaces may create conditions requiring special attention to avoid unsatisfactory operation of installed gas utilization equipment.



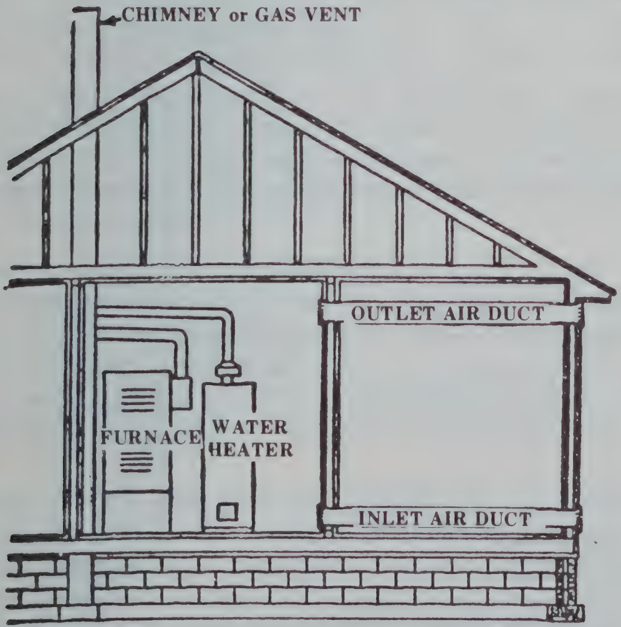
NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 2. Equipment Located in Confined Spaces; All Air from Outdoors — Inlet Air from Ventilated Crawl Space and Outlet Air to Ventilated Attic. See 5.3.3-b.



NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 3. Equipment Located in Confined Spaces; All Air from Outdoors Through Ventilated Attic. See 5.3.3-b.



NOTE: Each air duct opening shall have a free area of not less than one square inch per 2,000 Btu per hour of the total input rating of all equipment in the enclosure.*

* If the equipment room is located against an outside wall and the air openings communicate directly with the outdoors, each opening shall have a free area of not less than one square inch per 4,000 Btu per hour of the total input rating of all equipment in the enclosure.

Fig. 4. Equipment Located in Confined Spaces; All Air from Outdoors. See 5.3.3-b.

5.4 Equipment on Roofs.

5.4.1 General:

a. Gas utilization equipment on roofs shall be designed or enclosed so as to withstand climatic conditions in the area in which they are installed. If enclosures are provided, each enclosure shall permit easy entry and movement, shall be of reasonable height, and shall have at least 30-inch clearance between the entire service access panel(s) of the equipment and the wall of the enclosure.

b. Roofs on which equipment is to be installed shall be capable of supporting the additional load or shall be reinforced to support the additional load.

c. All access locks, screws and bolts shall be of corrosion-resistant material.

5.4.2 Installation of Equipment on Roofs:

a. Gas utilization equipment shall be installed in accordance with its listing and the manufacturer's installation instructions.

b. Equipment shall be installed on a well-drained surface of the roof. At least 6 feet clearance shall be available between any part of the equipment and the edge of a roof or similar hazard, or rigidly fixed rails or guards at least 42 inches in height shall be provided on the exposed side except that parapets or other building structure at least 42 inches in height may be utilized in lieu of rails or guards.

c. All equipment requiring an external source of electrical power for its operation shall be provided with an accessible electrical disconnect means near the equipment, which will completely deenergize the equipment, and a 120-volt A-C grounding type convenience outlet on the roof adjacent to the equipment. The convenience outlet shall be on the supply side of the disconnect switch.

d. When water stands on the roof at the equipment or in the passageways to the equipment, or when the roof is of a design having a water seal, a suitable platform or walkway or both shall be provided above the water line. Such platform(s) or walkway(s) shall be located adjacent to the equipment and control panels so that the equipment can be safely serviced when water stands on the roof.

5.4.3 Access to Equipment on Roofs:

a. Gas utilization equipment located on roofs or other elevated locations shall be accessible.

b. Buildings of more than 15 feet in height shall have an inside means of access to the roof.

c. The inside means of access shall be a permanent, or fold-away, inside stairway or ladder, terminating in an enclosure, scuttle or trap door. Such scuttles or trap doors shall be at least 24 inches by 24 inches in size, shall open easily and safely under all conditions, especially snow, and shall be constructed so as to permit access from the roof side unless deliberately locked on the inside.

At least 6 feet of clearance shall be available between the access opening and the edge of the roof or similar hazard, or rigidly fixed rails or guards at least 42 inches in height shall be provided on the exposed side; parapets or other building structure at least 42 inches in height may be utilized in lieu of guards or rails.

d. Proper permanent lighting shall be provided at the roof access. The switch for such lighting shall be located inside the building near the access means leading to the roof.

5.4.4 Additional Provisions: Also see 5.1.22, 5.2.1 and 7.14.3.

5.5 Equipment Connections to Building Piping.

5.5.1 Connecting Gas Equipment: Gas utilization equipment shall be connected to the building piping in compliance with 5.5.4 by one of the following:

a. Rigid metallic pipe and fittings.

b. Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.

c. Listed gas appliance connectors used in accordance with the terms of their listing that are completely in the same room as the equipment.

d. Listed gas hose connectors in accordance with 5.5.2.

e. Gas-fired commercial cooking equipment listed for use with casters or otherwise subject to movement for cleaning, and other large and heavy gas utilization equipment that may be moved, shall be connected by a listed appliance connector complying with the Standard for Connectors for Movable Gas Appliances, ANSI Z21.69.

f. In "b" and "c" above, the connector or tubing shall be installed so as to be protected against physical and thermal damage. Aluminum-alloy tubing and connectors shall be coated to protect against external corrosion where they are in contact with masonry, plaster or insulation or are subject to repeated wettings by such liquids as water (except rain water), detergents or sewage.

5.5.2 **Use of Gas Hose Connectors:** Listed gas hose connectors shall be used in accordance with the terms of their listing as follows:

a. **Indoor:** Indoor gas hose connectors may be used with laboratory, shop or ironing equipment that requires mobility during operation. A shutoff valve shall be installed where the connector is attached to the building piping. The connector shall be of minimum length but shall not exceed 6 feet. The connector shall not be concealed and shall not extend from one room to another nor pass through wall partitions, ceilings or floors.

b. **Outdoor:** Outdoor gas hose connectors may be used to connect portable outdoor gas-fired equipment. A shutoff valve or a listed quick-disconnect device shall be installed where the connector is attached to the supply piping and in such a manner to prevent the accumulation of water or foreign matter. This connection shall only be made in the outdoor area where the equipment is to be used.

5.5.3 **Connection of Portable and Mobile Industrial Gas Equipment:**

a. Portable industrial gas utilization equipment or equipment requiring mobility or subject to vibration may be connected to the building gas piping system by the use of flexible hose suitable and safe for the conditions under which it may be used.

b. Industrial gas utilization equipment requiring mobility may be connected to the rigid piping by the use of swivel joints or couplings which are suitable for the service required. Where swivel joints or couplings are used, only the minimum number required shall be installed.

c. Industrial gas utilization equipment subject to vibration may be connected to the building piping system by the use of all metal flexible connectors suitable for the service required.

d. Where flexible connections are used, they shall be of the minimum practical length and shall not extend from one room to another nor pass through any walls, partitions, ceilings or floors. Flexible connections shall not be used in any concealed location.

They shall be protected against physical or thermal damage and shall be provided with gas shutoff valves in readily accessible locations in rigid piping upstream from the flexible connections.

5.5.4 **Equipment Shutoff Valves and Connections:** Any gas utilization equipment connected to a piping system shall have an accessible, approved manual shutoff valve installed upstream of any connector and within 6 feet of the equipment it serves. A union or flanged connection shall be provided downstream from this valve to permit removal of controls.

5.5.5 **Quick-Disconnect Devices:** Gas utilization equipment connectors may be connected to the building piping by means of a listed quick-disconnect device, and when installed indoors, a manual shutoff valve shall be installed upstream of the quick-disconnect device.

5.5.6 **Sediment Trap:** If a sediment trap is not incorporated as a part of the gas utilization equipment and if dirt or other foreign material is a problem, a tee fitting with the bottom outlet plugged or capped shall be installed as close to the inlet of the equipment as practical (see Figure 5). Illuminating appliances and outdoor grills need not be so installed.

5.6 Electrical.

5.6.1 **Electrical Connections:** Electrical connections between gas utilization equipment and the building wiring, including the grounding of the equipment, shall conform to the National Electrical Code, ANSI/NFPA 70.

5.6.2 **Electric Ignition and Control Devices:** Electrical ignition, burner control and electrical vent damper devices shall not permit unsafe operation of the gas utilization equipment in the event of electrical power interruption or when the power is restored.

5.6.3 **Electrical Circuit:** The electrical circuit employed for operating the automatic main gas-control valve, automatic pilot, room temperature thermostat, limit control or other electrical devices used with the gas utilization equipment shall be in accordance with the wiring diagrams supplied with the equipment.

5.6.4 **Continuous Power:** All gas utilization equipment using electrical controls shall have the controls connected into a permanently live electric circuit, i.e., one that is not controlled by a light switch. Central heating equipment shall be provided with a separate electrical circuit.

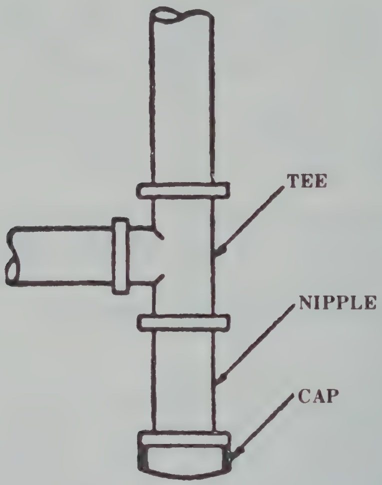


Fig. 5. A Method of Installing a Trap.

5.7 Room Temperature Thermostats.

5.7.1 Locations: Room temperature thermostats shall be installed in accordance with the manufacturer's instructions.

5.7.2 Drafts: Any hole in the plaster or panel through which the wires pass from the thermostat to the gas utilization equipment being controlled shall be sealed so as to prevent drafts from affecting the thermostat.

PART 6

INSTALLATION OF SPECIFIC EQUIPMENT

6.1 General.

a. This Part is primarily applicable to nonindustrial type gas utilization equipment and installations and, unless specifically indicated, does not apply to industrial type equipment and installations. Listed gas utilization equipment shall be installed in accordance with their listing and the manufacturer's instructions, or as elsewhere specified in this Part. Unlisted equipment shall be installed as specified in this Part as applicable to the equipment.

For additional information concerning particular gas equipment and accessories, including industrial types, reference can be made to the standards listed in Appendix A.

b. Gas utilization equipment shall not be installed so its combustion and ventilation air is obtained only from a bedroom or bathroom unless the bedroom or bathroom is an unconfined space (see 5.3.2 and Part 10, Definitions).

6.2 Air Conditioning Equipment.

6.2.1 Independent Gas Piping: Gas piping serving heating gas utilization equipment may also serve cooling equipment when heating and cooling equipment cannot be operated simultaneously. (See 2.4.)

6.2.2 Connection of Gas Engine-Powered Air Conditioners: To protect against the effects of normal vibration in service, gas engines shall not be rigidly connected to the gas supply piping.

6.2.3 Clearances for Indoor Installation:

a. Listed air conditioning equipment installed in rooms which are large in comparison with the size of the equipment shall be installed with clearances not less than those specified in Line I of Table V except as provided in "1," "2" and "3" below.

1. Air conditioning equipment listed for installation at lesser clearances than those specified in Table V may be installed in accordance with its listing and the manufacturer's instructions.

2. Air conditioning equipment listed for installation at greater clearances than those specified in Table V shall be installed in accordance with its listing and the manufacturer's instructions unless protected as specified in "3."
3. Air conditioning equipment installed in rooms large in comparison with the size of the equipment may be installed with reduced clearances to combustible material provided the combustible material or the equipment is protected as described in Table VI.

b. Air conditioning equipment installed in spaces such as alcoves and closets shall be specifically listed for such installation and installed in accordance with the terms of its listing. The installation clearances for air conditioning equipment in rooms not large in comparison with the size of equipment shall be as specified in the listing, regardless of whether the enclosure is of combustible or noncombustible material, and shall not be reduced by the protection methods described in Table VI.

c. Unlisted air conditioning equipment shall be installed with clearances from combustible material of not less than 18 inches above the equipment and at the sides, front and rear, and 9 inches from the draft hood.

d. When the plenum for an air conditioner which includes provisions for heating air is adjacent to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish when the clearance specified is 2 inches or less.

e. The clearance to this equipment shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. (See 5.2.1, 5.3 and 7.10.8.)

6.2.4 **Erection and Mounting:** Air conditioning equipment shall be erected in accordance with the manufacturer's instructions. Unless the equipment is listed for installation on a combustible surface such as a floor or roof, or unless the surface is protected in an approved manner,* it shall be installed on a surface of noncombustible construction with noncombustible material and surface finish and with no combustible material against the underside thereof.

6.2.5 **Plenum Chambers and Air Ducts:** A plenum chamber supplied as a part of the air conditioning equipment shall be installed in accordance with the manufacturer's instructions. When a plenum chamber is not supplied with the equipment, any fabrication and installation instructions provided by the manufacturer shall be followed. The method of connecting supply and return ducts shall facilitate proper circulation of air. (Reference may be made to the Standard for the Installation of Air Conditioning and Ventilating Systems, ANSI/NFPA 90A, or the Standard for the Installation of Warm Air Heating and Air Conditioning Systems, ANSI/NFPA 90B.)

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*For details of protection, refer to Appendix E of the National Building Code (1976).

When the air conditioner is installed within a room not large in comparison with the size of the equipment, the air circulated by the equipment shall be handled by ducts which are sealed to the casing of the equipment and which separate the circulating air from the combustion and ventilation air.

6.2.6 **Refrigeration Coils:** (See 6.3.7 and 6.3.8.)

6.2.7 **Switches in Electrical Supply Line:** Means for interrupting the electrical supply to the air conditioning equipment and to its associated cooling tower (if supplied and installed in a location remote from the air conditioner) shall be provided within sight of and not over 50 feet from the air conditioner and cooling tower.

6.3 Central Heating Boilers and Furnaces.

6.3.1 Clearance:

a. Central heating boilers and furnaces installed in rooms large in comparison with the size of the equipment, shall be installed with clearances not less than specified in Table V except as provided in "1" and "2" below.

1. Central heating furnaces and boilers listed for installation at lesser clearances than specified in Table V may be installed in accordance with their listing and the manufacturer's instructions.
2. Central heating furnaces and boilers installed in rooms large in comparison with the size of the equipment may be installed with reduced clearances to combustible material provided the combustible material or the equipment is protected as described in Table VI.

b. Central heating furnaces and boilers installed in spaces such as alcoves and closets shall be specifically listed for such installation and installed in accordance with the terms of listing.

Table V

Clearances to Combustible Material for Furnaces and Boilers Installed in Rooms Which Are Large in Comparison With Size of Equipment, Except as Provided in 6.3.1-a (See Note 9)

	Minimum Clearance, Inches				
	Above and Sides of Bonnet or Plenum	Jacket Sides and Rear	Front (See Note 1)	Draft Hood and Barometric Draft Regulator	Vent Connector (See Note 2)
I. Listed automatically fired, forced air or gravity system, with 250 F temperature limit control.	2 (See Notes 3 and 4)	6	18	6	6 (See Note 10)
II. Unlisted automatically fired, forced air or gravity system, equipped with temperature limit control which cannot be set higher than 250 F.	6 (See Note 5)	6	18	18 (See Note 6)	18 (See Note 6)
III. Listed Automatically Fired Heating Boilers—Steam boilers operating at not over 15 psi gage pressure and hot water boilers operating at not in excess of 250 F.	6 (See Note 7)	6	18	6	6 (See Note 10)
IV. Unlisted Automatically Fired Heating Boilers—Steam boilers operating at not over 15 psi gage pressure and hot water boilers operating at not in excess of 250 F.	6 (See Note 7)	6	18	18 (See Note 6)	18 (See Note 6)
V. Central heating boilers and furnaces, other than above.	18 (See Note 8)	18	18	18 (See Note 6)	18 (See Note 6)

NOTES APPLICABLE TO TABLE V

1. Front clearance shall be sufficient for servicing the burner and furnace or boiler.

2. The vent connector clearance does not apply to listed Type B gas vents.

3. This clearance may be reduced to 1 inch for a listed forced air or gravity furnace equipped with:
   a. A limit control that cannot be set higher than 200 F, or
   b. A marking to indicate that the outlet air temperature cannot exceed 200 F.

4. Clearance from supply ducts within 3 feet of the plenum shall not be less than that specified from the bonnet or plenum. No clearance is necessary beyond this distance.

5. Clearance from supply ducts within 6 feet of the plenum shall not be less than 6 inches. No clearance is necessary beyond this distance.

6. For unlisted gas utilization equipment equipped with an approved draft hood, this clearance may be reduced to 9 inches.

7. This clearance is above top of boiler.

8. Clearance from supply ducts shall not be less than 18 inches out to 3 feet from the bonnet or plenum, not less than 6 inches from 3 feet to 6 feet, and not less than 1 inch beyond 6 feet.

9. Rooms which are large in comparison with the size of the equipment are rooms having a volume equal to at least 12 times the total volume of an air conditioning appliance or furnace and at least 16 times the total volume of a boiler or water heater. Total volume of an appliance is determined from exterior dimensions and is to include fan compartments and burner vestibules, when used. When the actual ceiling height of a room is greater than 8 feet, the volume of a room shall be figured on the basis of a ceiling height of 8 feet.

10. These clearances shall apply unless the listing of an appliance specifies different clearances, in which case the listed clearances shall apply.

Table VI

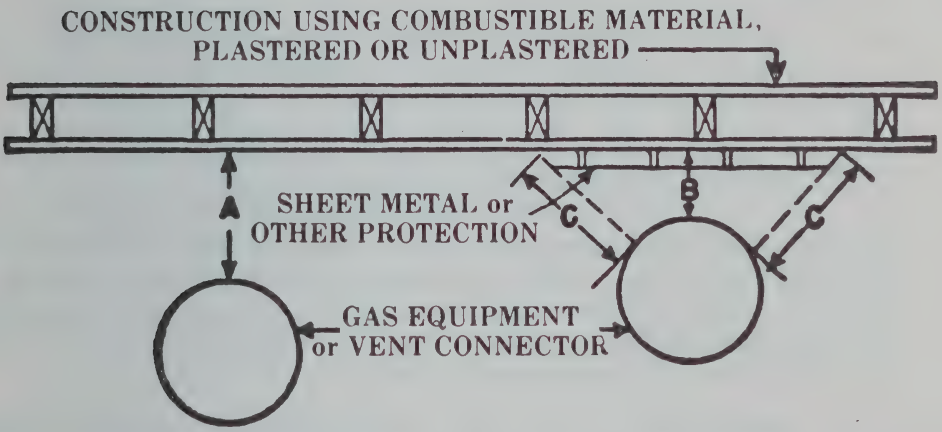
Clearances (Inches) With Specified Forms of Protection*

Type of Protection Applied to the combustible material unless otherwise specified and covering all surfaces within the distance specified as the required clearance with no protection. (See Fig. 6.) Thicknesses are minimum.	Where the required Clearance with no protection is: 36 inches			18 inches			12 inches		9 inches	6 inches		
	Above	Sides & Rear	Vent Connector	Above	Sides & Rear	Vent Connector	Above	Sides & Rear	Vent Connector	Above	Sides & Rear	Vent Connector
(a) 1/4 in. insulating millboard** spaced out 1"† . . .	30	18	30	15	9	12	9	6	6	3	2	3
(b) 28 gage sheet metal on 1/4" insulating millboard**	24	18	24	12	9	12	9	6	4	3	2	2
(c) 28 gage sheet metal spaced out 1"†	18	12	18	9	6	9	6	4	4	2	2	2
(d) 28 gage sheet metal on 1/8" insulating millboard** spaced out 1"†	18	12	18	9	6	9	6	4	4	2	2	2
(e) 1/4" insulating millboard** on 1" mineral wool bats reinforced with wire mesh or equivalent	18	12	18	6	6	6	4	4	4	2	2	2
(f) 22 gage sheet metal on 1" mineral wool bats reinforced with wire or equivalent	18	12	12	4	3	3	2	2	2	2	2	2
(g) 1/4" insulating millboard**	36	36	36	18	18	18	12	12	9	4	4	4

*All clearances shall be measured from the outer surface of the equipment to the combustible material disregarding any intervening protection applied to the combustible material.

**A factory fabricated board formed with noncombustible materials, normally fibers, and having a thermal conductivity in the range of 1 Btu inch per square foot per °F, or less.

†Spacers shall be of noncombustible material.


CONSTRUCTION USING COMBUSTIBLE MATERIAL, PLASTERED OR UNPLASTERED
A
SHEET METAL or OTHER PROTECTION
B
C
C
GAS EQUIPMENT or VENT CONNECTOR

A equals the clearance with no protection specified in Tables V and IX and in the sections applying to various types of equipment.
B equals the reduced clearance permitted in accordance with Table VI. The protection applied to the construction using combustible material shall extend far enough in each direction to make C equal to A.

Fig. 6. Extent of Protection Necessary to Reduce Clearances from Gas Equipment or Vent Connectors.

The installation clearances for furnaces and boilers in rooms not large in comparison with the size of the equipment shall be as specified in the listing, regardless of whether the enclosure is of combustible or noncombustible material, and shall not be reduced by the protection methods described in Table VI.

c. When the plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish when the clearance specified is 2 inches or less.

d. The clearance to this equipment shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. (See 5.2.1, 5.3 and 7.10.8.)

6.3.2 **Erection and Mounting:** A central heating boiler or furnace shall be erected in accordance with the manufacturer's instructions and shall be installed on a floor of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof or on fire-resistive slabs or arches having no combustible material against the underside thereof, unless listed for installation on a combustible floor or the floor is protected in an approved manner.*

6.3.3 **Temperature or Pressure Limiting Devices:** Steam and hot water boilers respectively shall be provided with approved automatic limiting devices for shutting down the burner(s) to prevent boiler steam pressure or boiler water temperature from exceeding the maximum allowable working pressure or temperature.

Safety limit controls shall not be used as operating controls.

6.3.4 **Low Water Cutoff:** Hot water boilers installed above the radiation level and all steam boilers shall be provided with an automatic means to shut off the fuel supply to the burner(s) if the boiler water level drops to the lowest safe water line.

6.3.5 **Steam Safety and Pressure Relief Valves:** Steam and hot water boilers shall be equipped, respectively, with listed or approved steam safety or pressure relief valves of appropriate discharge capacity and conforming with ASME requirements.†

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*For details of protection, refer to Appendix E of the National Building Code (1976).

†For details of requirements on low-pressure heating boiler safety devices refer to ANSI/ASME Boiler and Pressure Vessel Code, 1983 Edition, Section IV, Heating Boilers.

6.3.6 Plenum Chambers and Air Ducts:

a. Plenum chambers and air ducts shall be installed in accordance with the Standard for the Installation of Air Conditioning and Ventilating Systems, ANSI/NFPA 90A, or the Standard for the Installation of Warm Air Heating and Air Conditioning Systems, ANSI/NFPA 90B.

b. A plenum chamber supplied as a part of a furnace shall be installed in accordance with the manufacturer's instructions.

c. When a plenum chamber is not supplied with the furnace, any fabrication and installation instructions provided by the manufacturer shall be followed. The method of connecting supply and return ducts shall facilitate proper circulation of air. (Reference may be made to the Standard for the Installation of Air Conditioning and Ventilating Systems, ANSI/NFPA 90A and to the Standard for the Installation of Warm Air Heating and Air Conditioning Systems, ANSI/NFPA 90B.)

d. When a furnace is installed so supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace.

6.3.7 Refrigeration Coils:

a. A refrigeration coil shall not be installed in conjunction with a forced air furnace when circulation of cooled air is provided by the furnace blower, unless the blower has sufficient capacity to overcome the external static resistance imposed by the duct system and cooling coil at the air throughput necessary for heating or cooling, whichever is greater.

b. Furnaces shall not be located upstream from cooling units, unless the cooling unit is designed or equipped so as not to develop excessive temperature or pressure.

c. Refrigeration coils shall be installed in parallel with or on the downstream side of central furnaces to avoid condensation in the heating element, unless the furnace has been specifically listed for downstream installation. With a parallel flow arrangement, the dampers or other means used to control flow of air shall be sufficiently tight to prevent any circulation of cooled air through the furnace.

d. Means shall be provided for disposal of condensate and to prevent dripping of condensate on the heating element.

6.3.8 Cooling Units Used with Heating Boilers:

a. Boilers, when used in conjunction with refrigeration systems, shall be installed so that the chilled medium is piped in parallel with the heating boiler with appropriate valves to prevent the chilled medium from entering the heating boiler.

b. When hot water heating boilers are connected to heating coils located in air handling units where they may be exposed to refrigerated air circulation, such boiler piping systems shall be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

6.4 Clothes Dryers.

6.4.1 Clearance:

a. Listed Type 1 clothes dryers shall be installed with a minimum clearance of 6 inches from adjacent combustible material, except that clothes dryers listed for installation at lesser clearances may be installed in accordance with their listing. Type 1 clothes dryers installed in closets shall be specifically listed for such installation.

b. Listed Type 2 clothes dryers shall be installed with clearances of not less than shown on the marking plate and in the manufacturer's instructions. Type 2 clothes dryers designed and marked "For use only in noncombustible locations" shall not be installed elsewhere.

c. Unlisted clothes dryers shall be installed with clearances to combustible material of not less than 18 inches. Combustible floors under unlisted clothes dryers shall be protected in an approved manner.*

6.4.2 Exhausting to the Outside Air:

a. Type 1 clothes dryers installed in closets shall be exhausted to the outside air, and no other fuel-burning appliance shall be installed in the same closet. Type 1 clothes dryers shall not be installed in bathrooms or bedrooms unless exhausted to the outside air.

b. Type 2 clothes dryers shall be exhausted to the outside air.

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*For details of protection, refer to Appendix E of the National Building Code (1976).

6.4.3 Provisions for Make-Up Air:

a. When a Type 1 clothes dryer is exhausted to the outside, consideration shall be given to provision for make-up air. (See 5.3.6.) Provision for make-up air shall be provided for closet installed Type 1 clothes dryers in accordance with the manufacturer's installation instructions.

b. Provision for make-up air shall be provided for Type 2 clothes dryers, with a minimum free area (see 5.3.5) of one square inch for each 1,000 Btu per hour total input rating of the dryer(s) installed.

6.4.4 Exhaust Ducts for Type 1 Clothes Dryers:

a. A clothes dryer exhaust duct shall not be connected into any vent connector, gas vent, chimney, crawl space, attic or other similar concealed space.

b. Ducts for exhausting clothes dryers shall not be put together with sheet-metal screws or other fastening means which extend into the duct and which would catch lint and reduce the efficiency of the exhaust system.

6.4.5 Exhaust Ducts for Type 2 Clothes Dryers:

a. Exhaust ducts for Type 2 clothes dryers shall comply with 6.4.4.

b. Exhaust ducts for Type 2 clothes dryers shall be constructed of sheet metal or other noncombustible material. Such ducts shall be equivalent in strength and corrosion resistance to ducts made of galvanized sheet steel not less than 0.0195 inch thick.†

c. Type 2 clothes dryers shall be equipped or installed with lint controlling means.

d. Exhaust ducts for Type 2 clothes dryers shall have a clearance of at least 6 inches to combustible material except as provided in "e."

e. Exhaust ducts for Type 2 clothes dryers may be installed with reduced clearances to combustible material provided the combustible material is protected as described in Table VI.

f. When ducts pass through walls, floors or partitions, the space around the duct shall be sealed with noncombustible material.

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†This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

g. Multiple installations of Type 2 clothes dryers shall be made in a manner to prevent adverse operation due to back pressures that might be created in the exhaust systems.

6.4.6 **Multiple Family or Public Use:** All clothes dryers installed for multiple family or public use shall be equipped with approved safety shutoff devices and shall be installed as specified for a Type 2 clothes dryer under 6.4.5.

6.5 Commercial Cooking Equipment, Floor-Mounted.

6.5.1 **Clearance for Listed Equipment:** Listed floor-mounted commercial cooking equipment, such as hotel and restaurant ranges, deep fat fryers, unit broilers, gas-fired kettles, steam cookers, steam generators and commercial baking and roasting ovens, shall be installed at least 6 inches from combustible material except that at least a 2-inch clearance shall be maintained between a draft hood and combustible material. Floor-mounted commercial cooking equipment listed for installation at lesser clearances may be installed in accordance with its listing and the manufacturer's instructions. Equipment designed and marked "For use only in noncombustible locations" shall not be installed elsewhere.

6.5.2 **Clearance for Unlisted Equipment:**

a. Unlisted floor-mounted commercial cooking equipment, except as provided in "b" and "c" below, shall be installed to provide a clearance to combustible material of not less than 18 inches at the sides and rear of the equipment and from the vent connector and not less than 48 inches above cooking tops and at the front of the equipment.

b. Unlisted floor-mounted commercial cooking equipment may be installed in rooms, but not in partially enclosed areas such as alcoves, with reduced clearances to combustible material, provided the combustible material or the equipment is protected as described in Table VI.

c. Unlisted floor-mounted commercial cooking equipment may be installed in rooms, but not in partially enclosed areas such as alcoves, with reduced clearance of 6 inches to combustible material, provided the wall or combustible material is protected by sheet metal not less than 0.0152 inch thick,* fastened with noncombustible spacers that are spaced at not less than 2-foot vertical and horizontal intervals to provide a clearance of 1½ inches from such wall or material. Such protection shall extend at least

12 inches beyond the back, side, top or any other part of the equipment and the space between the sheet metal and wall or combustible material shall be open on both sides and top and bottom to permit circulation of air.

6.5.3 Mounting On Combustible Floor:

a. Listed floor-mounted commercial cooking equipment that is listed specifically for installation on floors constructed of combustible material may be mounted on combustible floors in accordance with its listing.

b. Listed floor-mounted commercial cooking equipment that is designed and marked "For use only in noncombustible locations" shall be mounted on floors of noncombustible construction with noncombustible flooring and surface finish and with no combustible material against the underside thereof, or on noncombustible slabs or arches having no combustible material against the underside thereof. Such construction shall in all cases extend not less than 12 inches beyond the equipment on all sides.

c. Floor-mounted commercial cooking equipment which is not listed for mounting on a combustible floor shall be mounted in accordance with "b" above or be mounted in accordance with one of the following:

1. When the equipment is set on legs which provide not less than 18 inches open space under the base of the equipment, or where it has no burners and no portion of any oven or broiler within 18 inches of the floor, it may be mounted on a combustible floor without special floor protection, provided there is at least one sheet metal baffle between the burner and the floor.
2. When the equipment is set on legs which provide not less than 8 inches open space under the base of the equipment, it may be mounted on combustible floors provided the floor under the equipment is protected with not less than ⅜-inch insulating millboard covered with sheet metal not less than 0.0195 inch thick.† The above specified floor protection shall extend not less than 6 inches beyond the equipment on all sides.
3. When the equipment is set on legs which provide not less than 4 inches under the base of the equipment, it may be mounted on combustible floors, provided the floor under the equipment is protected with hollow masonry not less than 4 inches in thickness covered with sheet metal not less than 0.0195 inch thick.* Such masonry courses shall be laid with

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*This corresponds to No. 26 U.S. Standard gage sheet steel with all applicable minus tolerances included.

†This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

ends unsealed and joints matched in such a way as to provide for free circulation of air through the masonry.

4. When the equipment does not have legs at least 4 inches high, it may be mounted on combustible floors, provided the floor under the equipment is protected by two courses of 4-inch hollow clay tile, or equivalent, with courses laid at right angles and with ends unsealed and joints matched in such a way as to provide for free circulation of air through such masonry courses and covered with steel plate not less than 3/16 inch in thickness.

6.5.4 Combustible Material Adjacent to Cooking Top: Any portion of combustible material adjacent to a cooking top section of a hotel or restaurant range, even though listed for close-to-wall installation, which is not shielded from the wall by a high shelf, warming closet, etc., shall be protected as specified in 6.5.2 for a distance of at least 2 feet above the surface of the cooking top.

6.5.5 For Use With Casters: Floor-mounted equipment with casters shall be listed for such construction and shall be installed in accordance with their listing and the accompanying instructions for limiting the movement of the equipment to prevent strain on the connection.

6.5.6 Install Level: Floor-mounted commercial cooking equipment shall be installed level on a firm foundation.

6.5.7 Ventilation: Adequate means shall be provided to properly ventilate the space in which commercial cooking equipment is installed to permit proper combustion of the gas. When exhaust fans are used for ventilation, special precautions may be necessary to avoid interference with the operation of the equipment.

6.6 Commercial Counter Appliances.

6.6.1 Vertical Clearance: A vertical distance of not less than 48 inches shall be provided between the top of all commercial hot plates and griddles and combustible material.

6.6.2 Clearance for Listed Appliances: Listed commercial counter appliances such as hot plates and griddles, food and dish warmers, and coffee brewers and urns, when installed on combustible surfaces, shall be set on their own bases or legs and shall be installed with a minimum horizontal clearance of 6 inches from combustible material, except that at least a 2-inch clearance shall be maintained between a draft hood and combustible material. Commercial counter appliances listed for installation at lesser clearances may be installed in accordance with their listing and the manufacturer's instructions.

6.6.3 Clearance for Unlisted Appliances: Unlisted commercial hot plates and griddles shall be installed with a horizontal clearance from combustible material of not less than 18 inches. Unlisted gas commercial counter appliances such as coffee brewers and urns, waffle bakers and hot water immersion sterilizers shall be installed with a horizontal clearance from combustible material of not less than 12 inches. Gas commercial counter appliances may be installed with reduced clearances to combustible material provided the combustible material is protected as described in Table VI. Unlisted food and dish warmers shall be installed with a horizontal clearance from combustible material of not less than 6 inches.

6.6.4 Mounting of Unlisted Appliances: Unlisted commercial counter appliances shall not be set on combustible material unless they have legs which provide not less than 4 inches of open space below the burners, and the combustible surface is protected with insulating millboard at least ¼ inch thick covered with sheet metal not less than 0.0122 inch thick,* or with equivalent protection.

6.7 Conversion Burners.

Installation of conversion burners shall conform to the Standard for Installation of Domestic Gas Conversion Burners, ANSI Z21.8.

6.8 Decorative Appliances for Installation in Vented Fireplaces.

6.8.1 Installation: A decorative appliance for installation in a vented fireplace shall be installed only in a vented fireplace having a working chimney flue and constructed of noncombustible materials. These appliances shall not be thermostatically controlled.

a. A listed decorative appliance for installation in a vented fireplace shall be installed in accordance with its listing and the manufacturer's instructions.

b. An unlisted decorative appliance for installation in a vented fireplace shall be installed in a fireplace having a permanent free opening, based on appliance input rating and chimney height, equal to or greater than that specified in Table VII.

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*This corresponds to No. 28 U.S. Standard gage sheet steel with all applicable minus tolerances included.

6.8.2 **Fireplace Screens:** A fireplace screen shall be installed with a decorative appliance for installation in a vented fireplace in order to provide protection from inadvertent contact with the appliance.

6.9 Decorative Appliances, Vented.

6.9.1 **Installation:**

a. A listed vented decorative appliance shall be installed in accordance with its listing and the manufacturer's instructions. They may be installed in or attached to combustible material when so listed.

b. Unlisted vented decorative appliances shall not be installed in or attached to combustible material. They shall have a clearance at the sides and rear of not less than 18 inches, except that appliances which make use of metal, asbestos or ceramic material to direct radiation to the front of the appliance shall have a clearance of 36 inches in front and, if constructed with a double back of metal or ceramic, may be installed with a clearance of 18 inches at the sides and 12 inches at the rear. Combustible floors under unlisted vented decorative appliances shall be protected in an approved manner.* Such unlisted appliances shall be equipped with a draft hood and be properly vented in accordance with Part 7.

c. Panels, grilles and access doors which must be removed for normal servicing operations shall not be attached to the building.

6.9.2 **Combustion and Circulating Air:** Adequate combustion and circulating air shall be provided (see 5.3).

6.10 Direct Make-Up Air Heaters.

6.10.1 **Installation:** Direct make-up air heaters shall not be used to supply any area containing sleeping quarters.

6.10.2 **Clearance from Combustible Material:** The clearances specified below shall not interfere with combustion air, accessibility for operation and servicing.

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*For details of protection, refer to mounting provisions for unlisted room heaters in Appendix E of the National Building Code (1976).

Table VII

Free Opening Area of Chimney Damper for Venting Flue Gases from Unlisted Decorative Appliances for Installation in Vented Fireplaces

Chimney Height, Feet	Minimum Permanent Free Opening, Square Inches*						
	8	13	20	29	39	51	64
	Appliance Input Rating, Btu Per Hour						
6	7,800	14,000	23,200	34,000	46,400	62,400	80,000
8	8,400	15,200	25,200	37,000	50,400	68,000	86,000
10	9,000	16,800	27,600	40,400	55,800	74,400	96,400
15	9,800	18,200	30,200	44,600	62,400	84,000	108,800
20	10,600	20,200	32,600	50,400	68,400	94,000	122,200
30	11,200	21,600	36,600	55,200	76,800	105,800	138,600

* The first six minimum permanent free openings (8 to 51 sq. in.) correspond approximately to the cross-sectional areas of chimneys having diameters of 3 through 8 inches, respectively. The 64 sq. in. opening corresponds to the cross-sectional area of standard 8 in. x 8 in. chimney tile.

a. Listed direct make-up air heaters shall be installed in accordance with their listings and the manufacturer's instructions.

b. Unlisted direct make-up air heaters shall be installed with clearances to combustible material of not less than 18 inches. Combustible floors under unlisted floor-mounted heaters shall be protected in an approved manner.†

6.10.3 Outside Air: All air handled by a direct make-up air heater, including combustion air, shall be brought in from outdoors. Indoor air may be added to the outdoor air stream after the outdoor air stream has passed the combustion zone.

6.10.4 Outside Louvers: If outside louvers of either the manual or automatic type are used, they shall be proved in the open position before the main burners can operate.

6.10.5 Controls:

a. Listed direct make-up air heaters shall be equipped with air-flow sensing devices, safety shutoff devices, operating temperature controls and thermally actuated temperature limit controls in accordance with the terms of their listings.

b. Unlisted direct make-up air heaters shall be equipped with:
1. Air-flow sensing devices so designed and installed as to shut off the gas to the main burners upon failure of either combustion air or main air supply. (Controls actuated by failure of the power supply to the blower motor do not meet the intent of this provision.)
2. Combustion safeguards, including manual reset safety shutoff devices.
3. Operating temperature controls and thermally actuated manual reset temperature limit controls, the latter of which shall not permit the discharge air temperature to exceed 150 F.

6.10.6 Input Ratings: Unlisted direct make-up air heaters shall have input ratings such that the ratio of gas input by volume to the total volume of gas-air mixture discharged will not exceed 0.2 percent.

6.10.7 Atmospheric Vents and Gas Relief or Bleeds: Direct make-up air heaters with enclosed valve trains shall be equipped with both atmospheric vent lines and gas reliefs or bleeds leading outdoors. Means shall be employed on these lines to prevent water from entering and to prevent stoppage by insects and foreign matter. An atmospheric vent line need not be provided on a valve train component equipped with a vent limiter.

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†For details of protection, refer to Appendix E of the National Building Code (1976).

6.10.8 Exhaust: The design of the installation shall include adequate provision to permit make-up air heaters to operate at rated capacity by providing properly designed relief openings or an interlocked power exhaust system.

6.10.9 Purging: The blower of an unlisted direct make-up air heater and the exhaust system shall be operated to effect at least four air changes of the combustion chamber before the gas to the main burners is ignited.

6.11 Duct Furnaces.

6.11.1 Clearances:

a. Listed duct furnaces shall be installed with clearances of at least 6 inches between adjacent walls, ceilings and floors of combustible material and the furnace draft hood, except that furnaces listed for installation at lesser clearances may be installed in accordance with their listings. In no case shall the clearance be such as to interfere with combustion air and accessibility. (See 5.2.1 and 5.3.)

b. Unlisted duct furnaces shall be installed with clearances to combustible material in accordance with the clearances specified for unlisted furnaces and boilers in Table V. Combustible floors under unlisted duct furnaces shall be protected in an approved manner.*

6.11.2 Erection of Equipment: Duct furnaces shall be erected and firmly supported in accordance with the manufacturer's instructions.

6.11.3 Access Panels: The ducts connected to duct furnaces shall have removable access panels on both the upstream and downstream sides of the furnace.

6.11.4 Location of Draft Hood and Controls: The controls, combustion air inlet and draft hoods for duct furnaces shall be located outside the ducts. The draft hood shall be located in the same enclosure from which combustion air is taken.

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*For details of protection, refer to Appendix E of the National Building Code (1976).

6.11.5 Circulating Air: When a duct furnace is installed so that supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace.

If the duct furnace is connected to a return air duct or any other inlet air restriction, the furnace shall be installed on the positive pressure side of the circulating air blower.

6.11.6 Duct Furnaces Used with Refrigeration Systems:

a. A duct furnace shall not be installed in conjunction with a refrigeration coil when circulation of cooled air is provided by the blower, unless the blower has sufficient capacity to overcome the external static resistance imposed by the duct system, furnace and the cooling coil at the air throughput necessary for heating or cooling, whichever is greater.

b. To avoid condensation within heating elements, duct furnaces used in conjunction with cooling equipment shall be installed in parallel with or on the upstream side of cooling coils, unless the duct furnace has been specifically listed for downstream installation. With a parallel flow arrangement, the dampers or other means used to control the flow of air shall be sufficiently tight to prevent any circulation of cooled air through the unit.

c. When duct furnaces are to be located upstream from cooling units, the cooling unit shall be so designed or equipped as to not develop excessive temperatures or pressures.

d. Duct furnaces may be installed downstream from evaporative coolers or air washers if the heating element is made of corrosion-resistant material. Stainless steel, ceramic-coated steel, or an aluminum-coated steel in which the bond between the steel and the aluminum is an iron-aluminum alloy, are considered to be corrosion-resistant. Air washers operating with chilled water which delivers air below the dew point of the ambient air at the equipment are considered as refrigeration systems.

6.11.7 Installation in Commercial Garages and Aircraft Hangars: Duct furnaces installed in garages for more than 3 motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with 5.1.10 and 5.1.11.

6.12 Floor Furnaces.

6.12.1 Installation:

a. Listed floor furnaces shall be installed in accordance with their listing and the manufacturer's instructions. They may be installed in combustible floors.

b. Unlisted floor furnaces shall not be installed in combustible floors.

c. Thermostats controlling floor furnaces shall not be located in a room or space which can be separated from the room or space in which the register of the floor furnace is located.

6.12.2 Temperature Limit Controls:

a. Listed automatically operated floor furnaces shall be equipped with temperature limit controls in accordance with the terms of their listing.

b. Unlisted automatically operated floor furnaces shall be equipped with a temperature limit control arranged to shut off the flow of gas to the burner in the event the temperature at the warm air outlet register exceeds 350 F above room temperature.

6.12.3 Combustion and Circulating Air: Adequate combustion and circulating air shall be provided (see 5.3).

6.12.4 Placement: The following provisions apply to furnaces that serve one story.

a. Floors: Floor furnaces shall not be installed in the floor of any doorway, stairway landing, aisle or passageway of any enclosure, public or private, or in an exitway from any such room or space.

b. Walls and Corners: The register of a floor furnace with a horizontal warm air outlet shall not be placed closer than 6 inches to the nearest wall. A distance of at least 18 inches from two adjoining sides of the floor furnace register to walls shall be provided to eliminate the necessity of occupants walking over the warm air discharge. The remaining sides may be placed not closer than 6 inches to a wall. Wall-register models shall not be placed closer than 6 inches to a corner.

c. Draperies: The furnace shall be placed so that a door, drapery or similar object cannot be nearer than 12 inches to any portion of the register of the furnace.

6.12.5 **Bracing:** The space provided for the furnace shall be framed with doubled joists and with headers not lighter than the joists.

6.12.6 **Support:** Means shall be provided to support the furnace when the floor register is removed.

6.12.7 **Clearance:** The lowest portion of the floor furnace shall have at least a 6-inch clearance from the general ground level, except that when the lower 6-inch portion of the floor furnace is sealed by the manufacturer to prevent entrance of water, the clearance may be reduced to not less than 2 inches. When these clearances are not present, the ground below and to the sides shall be excavated to form a "basin-like" pit under the furnace so that the required clearance is provided beneath the lowest portion of the furnace. A 12-inch clearance shall be provided on all sides except the control side, which shall have an 18-inch clearance.

6.12.8 **Access:** The space in which any floor furnace is installed shall be accessible by an opening in the foundation not less than 24 by 18 inches, or a trap door not less than 24 by 24 inches in any cross section thereof, and a passageway not less than 24 by 18 inches in any cross section thereof.

6.12.9 **Seepage Pan:** When the excavation exceeds 12 inches in depth or water seepage is likely to collect, a watertight copper pan, concrete pit or other suitable material shall be used, unless adequate drainage is provided or the equipment is sealed by the manufacturer to meet this condition. A copper pan shall be made of not less than 16-ounce-per-square-foot sheet copper. The pan shall be anchored in place so as to prevent floating, and the walls shall extend at least 4 inches above the ground level with at least 6 inches clearance on all sides, except the control side which shall have at least 18 inches clearance.

6.12.10 **Wind Protection:** Floor furnaces shall be protected, where necessary, against severe wind conditions.

6.12.11 **Upper Floor Installations:** Listed floor furnaces may be installed in an upper floor provided the furnace assembly projects below into a utility room, closet, garage or similar nonhabitable space. In such installations, the floor furnace shall be enclosed completely (entirely separated from the nonhabitable space) with means for air intake to meet the provisions of 5.3, with access for servicing, the minimum furnace clearances of 6 inches to all sides and bottom, and with the enclosure constructed of portland cement plaster or metal lath or other noncombustible material.

6.12.12 First Floor Installation: Listed floor furnaces installed in the first or ground floors of buildings need not be enclosed unless the basements of these buildings have been converted to apartments or sleeping quarters, in which case the floor furnace shall be enclosed as specified for upper floor installations and shall project into a non-habitable space.

6.13 Hot Plates and Laundry Stoves.

a. Listed domestic hot plates and laundry stoves installed on combustible surfaces shall be set on their own legs or bases. They shall be installed with minimum horizontal clearances of 6 inches from combustible material.

b. Unlisted domestic hot plates and laundry stoves shall be installed with horizontal clearances to combustible material of not less than 12 inches. Combustible surfaces under unlisted domestic hot plates and laundry stoves shall be protected in an approved manner.*

c. The vertical distance between tops of all domestic hot plates and laundry stoves and combustible material shall be at least 30 inches.

6.14 Household Cooking Appliances.

6.14.1 Floor-Mounted Units:

a. Clearance from Combustible Material: The clearances specified below shall not interfere with combustion air, accessibility for operation and servicing.

1. Listed floor-mounted household cooking appliances, except as noted in "2" and "3" below, when installed on combustible floors shall be set on their own bases or legs and shall be installed in accordance with their listing and the manufacturer's instructions.
2. Listed household cooking appliances with listed gas room heater sections shall be installed so that the warm air discharge side shall have a minimum clearance of 18 inches from adjacent combustible material. A minimum clearance of 36 inches shall be provided between the top of the heater section and the bottom of cabinets.
3. Household cooking appliances which include a solid or liquid fuel burning section shall be spaced from combustible

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*For details of protection, refer to Appendix E of the National Building Code (1976).

material and otherwise installed in accordance with the standards applying to the supplementary fuel section of the appliance.

4. Unlisted floor-mounted household cooking appliances shall be installed with at least a 6-inch clearance at the back and sides to combustible material. Combustible floors under unlisted appliances shall be protected in an approved manner.*

b. **Vertical Clearance Above Cooking Top:** Household cooking appliances shall have a vertical clearance above the cooking top of not less than 30 inches to combustible material or metal cabinets, except the clearance may be reduced to not less than 24 inches as follows:

1. The underside of the combustible material or metal cabinet above the cooking top is protected with not less than ¼-inch insulating millboard covered with sheet metal not less than 0.0122 inch thick,† or
2. A metal ventilating hood of sheet metal not less than 0.0122 inch thick† is installed above the cooking top with a clearance of not less than ¼ inch between the hood and the underside of the combustible material or metal cabinet, and the hood is at least as wide as the appliance is and is centered over the appliance.

c. **Install Level:** Cooking appliances shall be installed so that the cooking top or oven racks are level.

6.14.2 Built-In Units:

a. **Installation:** Listed built-in household cooking appliances shall be installed in accordance with their listing and the manufacturer's instructions. Listed built-in household cooking appliances may be installed in combustible material unless otherwise marked.

The installation shall not interfere with combustion air, accessibility for operation and servicing.

Unlisted built-in household cooking appliances shall not be installed in, or adjacent to, combustible material.

b. **Vertical Clearance:** Built-in top (or surface) cooking appliances shall have a vertical clearance above the cooking top of not less than 30 inches to combustible material or metal cabinets, except the clearance may be reduced to not less than 24 inches as follows:

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*For details of protection, refer to Appendix E of the National Building Code (1976).

†This corresponds to No. 28 U.S. Standard gage sheet steel with all applicable minus tolerances included.

1. The underside of the combustible material or metal cabinet above the cooking top is protected with not less than ¼-inch insulating millboard covered with sheet metal not less than 0.0122 inch thick† or,
2. A metal ventilating hood of sheet metal not less than 0.0122 inch thick† is installed above the cooking top with a clearance of not less than ¼ inch between the hood and the underside of the combustible material or metal cabinet, and the hood is at least as wide as the appliance is and is centered over the appliance.

c. **Horizontal Clearance:** The minimum horizontal distance from the center of the burner head(s) of a listed top (or surface) cooking appliance to vertical combustible walls extending above the top panel shall be not less than that distance specified by the permanent marking on the appliance.

d. **Install Level:** Built-in household cooking appliances shall be installed so that the cooking top, broiler pan or oven racks are level.

6.15 Illuminating Appliances.

6.15.1 Clearances for Listed Appliances: Listed illuminating appliances shall be installed in accordance with their listing and the manufacturer's instructions.

6.15.2 Clearances for Unlisted Appliances:

a. **Enclosed Type:**

1. Unlisted enclosed illuminating appliances installed outdoors shall be installed with clearances in any direction from combustible material of not less than 12 inches.
2. Unlisted enclosed illuminating appliances installed indoors shall be installed with clearances in any direction from combustible material of not less than 18 inches.

b. **Open-Flame Type:**

1. Unlisted open-flame illuminating appliances installed outdoors shall have clearances from combustible material not less than that specified in Table VIII. The distance from ground level to the base of the burner shall be at least 7 feet when installed within two feet of walkways. Lesser clearances may be used when acceptable to the authority having jurisdiction.

2. Unlisted open-flame illuminating appliances installed outdoors shall be equipped with a limiting orifice or other limiting devices which will maintain a flame height consistent with the clearance from combustible material, as given in Table VIII.
3. Appliances designed for flame heights in excess of 30 inches may be installed if acceptable to the authority having jurisdiction. Such appliances shall be equipped with a safety shutoff device or automatic ignition.
4. Unlisted open-flame illuminating appliances installed indoors shall have clearances from combustible material acceptable to the authority having jurisdiction.

Table VIII

Flame Height Above Burner Head, Inches	Minimum Clearance from Combustible Material, Feet*	
	Horizontal	Vertical
12	2	6
18	3	8
24	3	10
30	4	12

*Measured from the nearest portion of the burner head.

6.15.3 **Mounting on Buildings:** Illuminating appliances designed for wall or ceiling mounting shall be securely attached to substantial structures in such a manner that they are not dependent on the gas piping for support.

6.15.4 **Mounting on Posts:** Illuminating appliances designed for post mounting shall be securely and rigidly attached to a post.

Posts shall be rigidly mounted. The strength and rigidity of posts greater than 3 feet in height shall be at least equivalent to that of a 2½-inch-diameter post constructed of 0.064 inch thick* steel or a 1-inch Schedule 40 steel pipe. Posts 3 feet or less in height shall not be smaller than a ¾-inch Schedule 40 steel pipe.

Drain openings should be provided near the base of posts when there is a possibility of water collecting inside them.

6.15.5 **Gas Appliance Pressure Regulators:** When a gas appliance pressure regulator is not supplied with an illuminating appliance and the service line is not equipped with a service pressure regulator, an appliance pressure regulator shall be installed in the line to the illuminating appliance. For multiple installations, one regulator of adequate capacity may be used to serve a number of illuminating appliances.

6.16 Incinerators, Commercial-Industrial.

Commercial-industrial type incinerators shall be constructed and installed in accordance with the Standard on Incinerators, Waste and Linen Handling Systems and Equipment, ANSI/NFPA 82.

6.17 Incinerators, Domestic.

6.17.1 Clearance:

a. Listed incinerators shall be installed in accordance with their listing and the manufacturer's instructions, provided that in any case the clearance shall be sufficient to afford ready accessibility for firing, clean-out and necessary servicing.

b. The clearances to combustible material above a charging door shall be not less than 48 inches. The clearance may be reduced to 24 inches provided the combustible material is protected with sheet metal not less than 0.0122 inch thick† spaced out 1 inch on noncombustible spacers, or equivalent protection. Such protection shall extend 18 inches beyond all sides of the charging door opening. Listed incinerators designed to retain the flame during loading need not comply with this paragraph.

c. Unlisted incinerators shall be installed with clearances to combustible material of not less than 36 inches at the sides, top and back and not less than 48 inches at the front, but in no case shall the clearance above a charging door be less than 48 inches. Unlisted wall mounted incinerators shall be installed on a noncombustible wall communicating directly with a chimney.

d. Domestic type incinerators may be installed with reduced clearances to combustible material in rooms, provided the combustible material is protected as described in Table VI. In partially enclosed areas, such as alcoves, clearances shall not be so reduced.

e. When a domestic type incinerator that is refractory lined or insulated with heat insulating material is encased in common

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*This corresponds to No. 14 U.S. Standard gage sheet steel with all applicable minus tolerances included.

†This corresponds to No. 28 U.S. Standard gage sheet steel with all applicable minus tolerances included.

brick not less than 4 inches in thickness, the clearances may be reduced to 6 inches at the sides and rear, and the clearance at the top may be reduced to 24 inches provided that the construction using combustible material above the charging door and within 48 inches is protected with sheet metal not less than 0.0122 inch thick* spaced out 1 inch, or equivalent protection.

6.17.2 Mounting:

a. Listed incinerators specifically listed for installation on combustible floors may be so installed.

b. Unlisted incinerators, except as provided in "c" and "d" below, shall be mounted on the ground or on floors of noncombustible construction with noncombustible flooring or surface finish and with no combustible material against the underside thereof, or on noncombustible slabs or arches having no combustible material against the underside thereof. Such construction shall extend not less than 12 inches beyond the incinerator base on all sides, except at the front or side where ashes are removed where it shall extend not less than 18 inches beyond the incinerator.

c. Unlisted incinerators may be mounted on floors other than as specified in "b" above, provided the incinerator is so arranged that flame or hot gases do not come in contact with its base and, further, provided the floor under the incinerator is protected with hollow masonry not less than 4 inches thick, covered with sheet metal not less than 0.0195 inch thick.* Such masonry course shall be laid with ends unsealed and joints matched in such a way as to provide a free circulation of air from side to side through the masonry. The floor for 18 inches beyond the front of the incinerator or side where ashes are removed and 12 inches beyond all other sides of the incinerator shall be protected with not less than ¼-inch insulating millboard covered with sheet metal not less than 0.0195 inch thick† or with equivalent protection.

d. Unlisted incinerators which are set on legs that provide not less than 4 inches open space under the base of the incinerator may be mounted on floors other than as specified in "b" above, provided the incinerator is such that flame or hot gases do not come in contact with its base and, further, provided the floor under the incinerator is protected with not less than ¼-inch insulating millboard covered with sheet metal not less than 0.0195 inch thick*. The above specified floor protection shall extend not less than 18 inches beyond the front of the incinerator or side where ashes are removed and 12 inches beyond all other sides of the incinerator.

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*This corresponds to No. 24 U.S. Standard gage sheet steel with all applicable minus tolerances included.

6.17.3 **Draft Hood Prohibited:** Draft hoods shall not be installed in the vent connector of an incinerator.

6.17.4 **Venting:** Incinerators shall be vented in accordance with 7.3, 7.4, 7.6 and 7.9.

6.18 Infrared Heaters.

6.18.1 **Support:** Suspended type infrared heaters shall be safely and adequately fixed in position independent of gas and electric supply lines. Hangers and brackets shall be of noncombustible material.

Heaters subject to vibration shall be provided with vibration isolating hangers.

6.18.2 **Clearance:**

a. Listed heaters shall be installed with clearances from combustible material in accordance with their listing and the manufacturer's instructions.

b. Unlisted heaters shall be installed in accordance with clearances from combustible material acceptable to the authority having jurisdiction.

c. In locations used for the storage of combustible materials, signs shall be posted to specify the maximum permissible stacking height to maintain required clearances from the heater to the combustibles.

6.18.3 **Combustion and Ventilation Air:**

a. Where unvented infrared heaters are used, natural or mechanical means shall be provided to supply and exhaust at least 4 cfm per 1,000 Btu per hour input of installed heaters.

b. Exhaust openings for removing flue products shall be above the level of the heaters.

6.18.4 **Installation in Commercial Garages and Aircraft Hangars:** Overhead heaters installed in garages for more than 3 motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with 5.1.10 and 5.1.11.

6.19 Open Top Broiler Units.

6.19.1 Listed Units: Listed open top broiler units shall be installed in accordance with their listing and the manufacturer's instructions.

6.19.2 Unlisted Units: Unlisted open top broiler units shall be installed in accordance with the manufacturer's instructions, but shall not be installed in combustible material.

6.19.3 Protection Above Domestic Units: Domestic open top broiler units shall be provided with a metal ventilating hood not less than 0.0122 inch thick* with a clearance of not less than ¼ inch between the hood and the underside of combustible material or metal cabinets. A clearance of at least 24 inches shall be maintained between the cooking top and the combustible material or metal cabinet, and the hood shall be at least as wide as the open top broiler unit and centered over the unit. Listed domestic open top broiler units incorporating an integral exhaust system and listed for use without a ventilating hood need not be provided with a ventilating hood if installed in accordance with 6.14.1-b(1).

6.19.4 Commercial Units: Commercial open top broiler units shall be provided with ventilation in accordance with the Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, ANSI/NFPA 96.

6.20 Outdoor Cooking Appliances.

6.20.1 Listed Units: Listed outdoor cooking appliances shall be installed in accordance with their listing and the manufacturer's instructions.

6.20.2 Unlisted Units: Unlisted outdoor cooking appliances shall be installed outdoors with clearances to combustible material of not less than 36 inches at the sides and back and not less than 48 inches at the front. In no case shall the appliance be located under overhead combustible construction.

6.21 Pool Heaters.

6.21.1 Location: A pool heater shall be located or protected so as to minimize accidental contact of hot surfaces by persons.

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*This corresponds to No. 28 U.S. Standard gage sheet steel with all applicable minus tolerances included.

*For details of protection, refer to Appendix E of the National Building Code (1976).

6.21.2 Clearance:

a. In no case shall the clearances be such as to interfere with combustion air, draft hood or vent terminal clearance and relief, and accessibility for servicing.

b. A listed pool heater shall be installed in accordance with its listing and the manufacturer's instructions.

c. An unlisted pool heater shall be installed with a minimum clearance of 12 inches on all sides and the rear. A combustible floor under an unlisted pool heater shall be protected in an approved manner.*

6.21.3 Temperature or Pressure Limiting Devices:

a. An unlisted pool heater shall be provided with overtemperature protection or overtemperature and overpressure protection by means of an approved device(s).

b. When a pool heater is provided with overtemperature protection only, and is installed with any device in the discharge line of the heater that can restrict the flow of water from the heater to the pool (such as a check valve, shutoff valve, therapeutic pool valving, flow nozzles, etc.), a pressure relief valve shall be installed either in the heater or between the heater and the restrictive device.

6.21.4 Bypass Valves: If an integral bypass system is not provided as a part of the pool heater, a bypass line and valve shall be installed between the inlet and outlet piping for use in adjusting the flow of water through the heater.

6.21.5 Venting: A pool heater listed for outdoor installation shall be installed with the venting means supplied by the manufacturer and in accordance with the manufacturer's instructions. (See 7.7 and 7.14.)

6.22 Refrigerators.

6.22.1 Clearance: Refrigerators shall be provided with adequate clearances for ventilation at the top and back. They shall be installed in accordance with the manufacturer's instructions. If such instructions are not available, at least 2 inches shall be provided between the back of the refrigerator and the wall and at least 12 inches above the top.

6.22.2 Venting or Ventilating Kits Approved for Use with a Refrigerator: If an accessory kit is used for conveying air for burner combustion or unit cooling to the refrigerator from areas outside the room in which it is located, or for conveying combustion products diluted with air containing waste heat from the refrigerator to areas outside the room in which it is located, the kit shall be installed in accordance with the refrigerator manufacturer's instructions.

6.23 Room Heaters.

6.23.1 Installations in Sleeping Quarters or Bathrooms: Unvented room heaters shall not be installed in sleeping quarters or bathrooms.*

6.23.2 Installations in Institutions: Room heaters shall not be installed in institutions such as homes for the aged, sanitariums, convalescent homes, orphanages, etc.

6.23.3 Clearance: A room heater shall be placed so as not to cause a hazard to walls, floors, curtains, furniture, doors when open, etc., and to the free movements of persons within the room. Heaters designed and marked "For use in noncombustible fireplace only," shall not be installed elsewhere. Listed room heaters shall be installed in accordance with their listings and the manufacturer's instructions. In no case shall the clearances be such as to interfere with combustion air and accessibility. (See 5.2.1 and 5.3.)

Unlisted room heaters shall be installed with clearances from combustible material not less than the following:

a. **Circulating Type:** Room heaters having an outer jacket surrounding the combustion chamber, arranged with openings at top and bottom so that air circulates between the inner and outer jacket, and without openings in the outer jacket to permit direct radiation, shall have clearance at sides and rear of not less than 12 inches.

b. **Radiating Type:** Room heaters other than those described above as of circulating type shall have clearance at sides and rear of not less than 18 inches; except that heaters which make use of metal, asbestos or ceramic material to direct radiation to the front of the heater shall have a clearance of 36 inches in front, and if constructed with a double back of metal or ceramic may be installed with a clearance of 18 inches at sides and 12 inches at rear. Combustible floors under unlisted room heaters shall be protected in an approved manner.†

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*It is recommended that space heating appliances installed in all sleeping quarters or rooms generally kept closed be of the direct vent type (see 6.28).

6.23.4 Wall-Type Room Heaters: Wall-type room heaters shall not be installed in or attached to walls of combustible material unless listed for such installation.

6.24 Sauna Heaters.

6.24.1 Location and Protection:

a. A sauna heater shall be so located as to minimize the possibility of accidental contact by a person in the room.

b. A sauna heater shall be protected from accidental contact by a guard or barrier of material having a low coefficient of thermal conductivity. Wood is satisfactory for this application. The guard shall have no substantial effect on the transfer of heat from the heater to the room.

6.24.2 Installation of Heater:

a. A listed sauna heater shall be installed in accordance with its listing and the manufacturer's instructions.

b. An unlisted sauna heater shall be installed in accordance with the following:

1. The heater shall be installed on noncombustible flooring or on flooring which has been equivalently protected in an approved manner.*
2. The heater shall be installed in compliance with the manufacturer's instructions except that clearances to the sides, back and top of the heater shall be not less than 36 inches.

c. An unlisted sauna heater shall not be installed in or attached to combustible material.

d. A direct vent sauna heater shall be installed with the vent/air intake terminal in the outside atmosphere. The thickness of the wall on which the heater is mounted shall be within the range of wall thicknesses marked on the heater and covered in the manufacturer's installation instructions.

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†For details of protection, refer to Appendix E of the National Building Code (1976).

e. Panels, grilles and access doors which must be removed for normal servicing operations, shall not be attached to the building.

f. A sauna heater of other than the direct vent type shall be installed generally in accordance with Figure 7. If the combustion air inlet and the draft hood are in a dressing room adjacent to the sauna room, there shall be provisions to physically prevent blocking the combustion air inlet and the draft hood inlet, and to prevent physical contact with the draft hood and vent assembly, or warning notices shall be posted to avoid such contact. Any warning notice shall be easily readable, shall contrast with its background, and the wording shall be in letters not less than ¼ inch high.

6.24.3 **Connection:** The provisions of 5.5, Equipment Connections to Building Piping, shall be observed except that when access to controls is from an adjacent room, connections shall be made in that area.

6.24.4 **Combustion and Ventilation Air:**

a. Combustion air shall not be taken from inside the sauna room.

b. Adequate combustion and ventilation air for a heater not of the direct vent type shall be provided to the area in which the combustion air inlet and draft hood are located by suitable means (see 5.3).

6.24.5 **Means for Heat or Exposure Limitation:**

a. A sauna heater shall be equipped with a thermostat which will limit room temperature to 194 F. If the thermostat is not an integral part of the heater, the heat sensing element shall be located within 6 inches of the ceiling. If the heat sensing element is a capillary tube and bulb, the assembly shall be attached to the wall or other support, and shall be protected against physical damage.

b. A timer, if provided to control main burner operation, shall have a maximum operating time of 1 hour. The control for the timer shall be located outside the sauna room.

6.24.6 **Provisions for Sauna Room Equipped with a Gas-Fired Sauna Heater:**

a. A ventilation opening into the sauna room shall be provided. This shall be not less than a 4-inch by 8-inch opening near the top of the door into the sauna room.

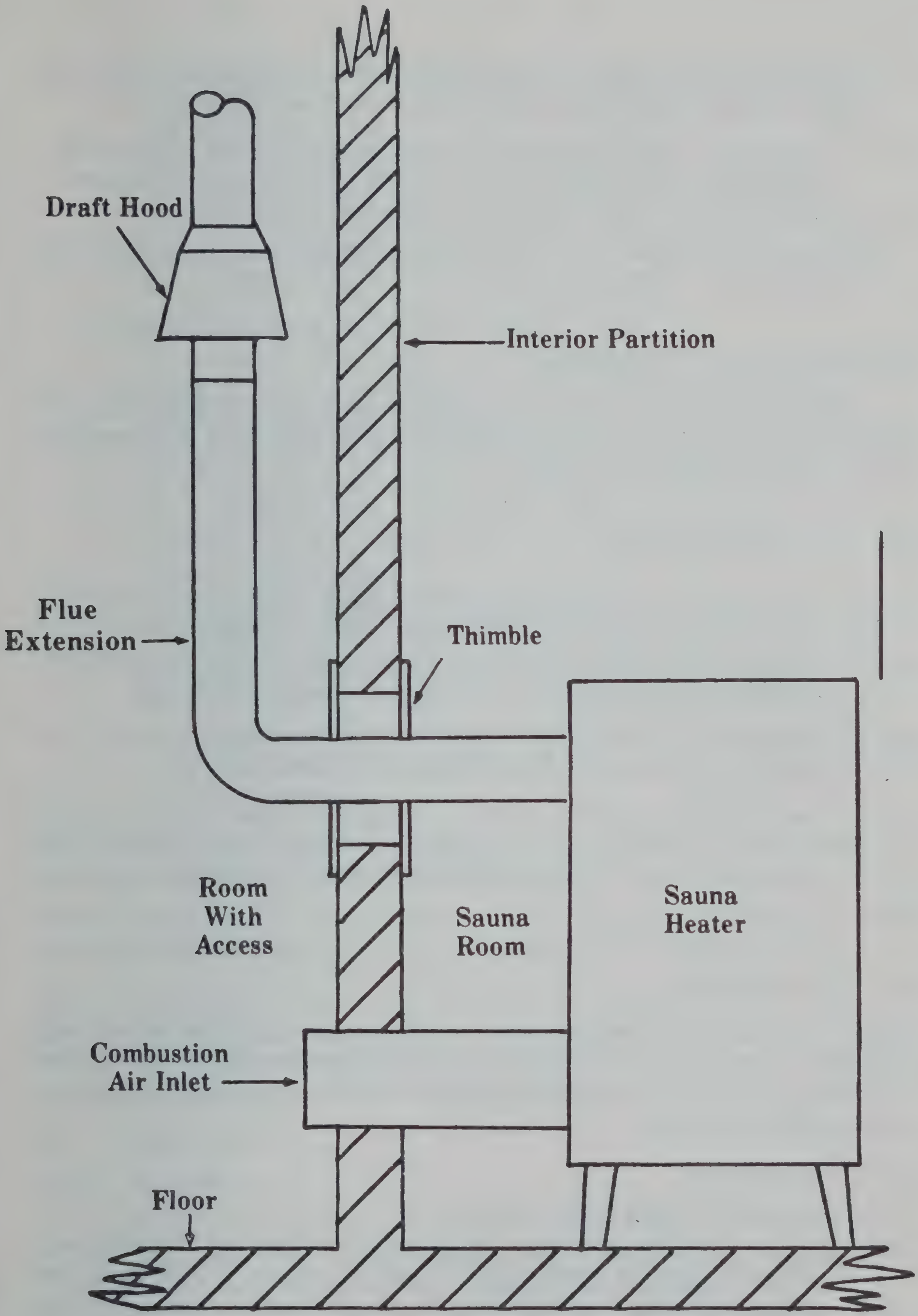

Fig. 7. Typical Sauna Heater Installation.

b. The following notice on permanent marking material shall be mechanically attached to the sauna room on the outside:

> "Warning: Do not exceed 30 minutes in sauna. Excessive exposure can be harmful to health. Any person with poor health should consult a physician before using sauna."

This marking shall contrast with its background and the wording shall be in letters not less than ¼ inch high.

* 6.25 Stationary Gas Engines.

The installation of gas engines shall conform with the Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, ANSI/NFPA 37.

6.26 Gas-Fired Toilets.

6.26.1 Clearance: A listed gas-fired toilet shall be installed in accordance with its listing and the manufacturer's instructions, provided that the clearance shall in any case be sufficient to afford ready accessibility for use, cleanout and necessary servicing.

6.26.2 Mounting: Listed gas-fired toilets specifically listed for installation on combustible floors may be so installed.

6.26.3 Installation: Vents or vent connectors which are located so they could be contacted during casual use of the room in which the toilet is installed shall be protected or shielded to prevent such contact.

6.27 Unit Heaters.

6.27.1 Support: Suspended type unit heaters shall be safely and adequately supported with due consideration given to their weight and vibration characteristics. Hangers and brackets shall be of noncombustible material.

6.27.2 Clearance:

a. Suspended Type Unit Heaters:

1. A listed unit heater shall be installed with clearances from combustible material of not less than 18 inches at the sides, 12 inches at the bottom and 6 inches above the top when the unit heater has an internal draft hood, or 1 inch above the top of the sloping side of a vertical draft hood.

2. A unit heater listed for reduced clearances shall be installed in accordance with its listing and the manufacturer's instructions.
3. Unlisted unit heaters shall be installed with clearances to combustible material of not less than 18 inches.
4. Clearances for servicing shall be in accordance with the manufacturer's recommendations contained in the installation instructions.

b. **Floor-Mounted Type Unit Heaters:**

1. A listed unit heater shall be installed with clearances from combustible material at the back and one side only of not less than 6 inches. When the flue gases are vented horizontally, the 6 inch clearance shall be measured from the draft hood or vent instead of the rear wall of the unit heater.
2. A unit heater listed for reduced clearances shall be installed in accordance with its listing and the manufacturer's instructions.
3. Floor-mounted type unit heaters may be installed on combustible floors if listed for such installation.
4. Combustible floors under unlisted floor-mounted unit heaters shall be protected in an approved manner.*
5. Clearances for servicing shall be in accordance with the manufacturer's recommendations contained in the installation instructions.

6.27.3 **Combustion and Circulating Air:** Adequate combustion and circulating air shall be provided (see 5.3).

6.27.4 **Ductwork:** A unit heater shall not be attached to a warm air duct system unless listed and marked for such installation.

6.27.5 **Installation in Commercial Garages and Aircraft Hangars:** Unit heaters installed in garages for more than 3 motor vehicles or in aircraft hangars shall be of a listed type and shall be installed in accordance with 5.1.10 and 5.1.11.

6.28 Wall Furnaces.

6.28.1 **Installation:**

a. A listed wall furnace shall be installed in accordance with its listing and the manufacturer's instructions. They may be installed in or attached to combustible material.

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*For details of protection, refer to Appendix E of the National Building Code (1976).

b. Unlisted wall furnaces shall not be installed in or attached to combustible material.

c. Vented wall furnaces connected to a Type B-W gas vent system listed only for single story shall be installed only in single story buildings or the top story of multistory buildings. Vented wall furnaces connected to a Type B-W gas vent system listed for installation in multistory buildings may be installed in single story or multistory buildings. Type B-W gas vents shall be attached directly to a solid header plate which serves as a fire stop at that point and which may be an integral part of the vented wall furnace. The stud space in which the vented wall furnace is installed shall be ventilated at the first ceiling level by installation of the ceiling plate spacers furnished with the gas vent. Fire stop spacers shall be installed at each subsequent ceiling or floor level penetrated by the vent. (See Figure 8 for Type B-W gas vent installation.)

d. Direct vent wall furnaces shall be installed with the vent/air intake terminal in the outside atmosphere. The thickness of the walls on which the furnace is mounted shall be within the range of wall thickness marked on the furnace and covered in the manufacturer's installation instructions.

e. Panels, grilles and access doors which must be removed for normal servicing operations shall not be attached to the building.

6.28.2 Location: Wall furnaces shall be located so as not to cause a hazard to walls, floors, curtains, furniture or doors. Wall furnaces installed between bathrooms and adjoining rooms shall not circulate air from bathrooms to other parts of the building.

6.28.3 Combustion and Circulating Air: Adequate combustion and circulating air shall be provided (see 5.3).

6.29 Water Heaters.

6.29.1 Prohibited Installations: Water heaters, with the exception of those having direct-vent systems, shall not be installed in bathrooms, bedrooms or any occupied rooms normally kept closed.

Single-faucet automatic instantaneous water heaters, as permitted under 7.1.2 in addition to the above, shall not be installed in kitchen sections of light housekeeping rooms or rooms used by transients.

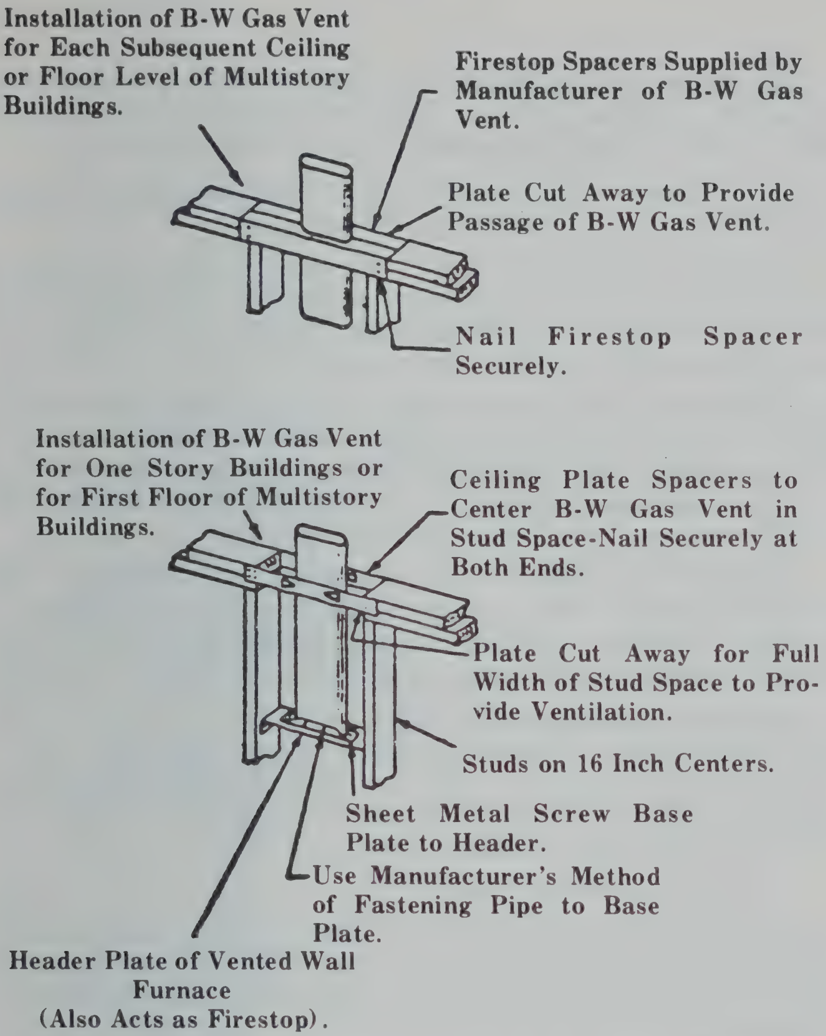
Installation of B-W Gas Vent for Each Subsequent Ceiling or Floor Level of Multistory Buildings.
Firestop Spacers Supplied by Manufacturer of B-W Gas Vent.
Plate Cut Away to Provide Passage of B-W Gas Vent.
Nail Firestop Spacer Securely.
Installation of B-W Gas Vent for One Story Buildings or for First Floor of Multistory Buildings.
Ceiling Plate Spacers to Center B-W Gas Vent in Stud Space-Nail Securely at Both Ends.
Plate Cut Away for Full Width of Stud Space to Provide Ventilation.
Studs on 16 Inch Centers.
Sheet Metal Screw Base Plate to Header.
Use Manufacturer's Method of Fastening Pipe to Base Plate.
Header Plate of Vented Wall Furnace (Also Acts as Firestop).

Fig. 8. Installation of Type B-W Gas Vents for Vented Wall Furnaces.

6.29.2 Location: Water heaters of other than the direct vent type shall be located as close as practicable to the chimney or gas vent.

6.29.3 Clearance:

a. In no case shall the clearances be such as to interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. Listed water heaters shall be installed in accordance with their listing and the manufacturer's instructions.

b. Unlisted water heaters shall be installed with a clearance of 12 inches on all sides and rear. Combustible floors under unlisted water heaters shall be protected in an approved manner.*

6.29.4 **Connections:** Water heaters shall be connected in a manner to permit observation, maintenance and servicing.

6.29.5 **Pressure Limiting Devices:** A water heater installation shall be provided with overpressure protection by means of an approved device constructed, listed and installed in accordance with nationally recognized standards for such devices.

6.29.6 **Temperature Limiting Devices:** An automatic storage-type water heater installation or a hot water storage vessel installation shall be provided with overtemperature protection by means of an approved device constructed, listed and installed in accordance with nationally recognized standards for such devices.

6.29.7 **Temperature, Pressure and Vacuum Relief Devices:** The installation of temperature, pressure and vacuum relief devices or combinations thereof, and automatic gas shutoff devices shall be in accordance with nationally recognized standards for such devices.

6.29.8 **Automatic Instantaneous Type:**

Cold Water Supply: The water supply to any automatic instantaneous water heater shall be such as to provide sufficient pressure to properly operate the water actuated control valve when drawing hot water from a faucet on the top floor.

6.29.9 **Circulating or Tank Types:**

a. **Connection to Boiler or Tank:** The method of connecting the circulating water heater to the tank shall provide proper circulation of water through the heater and permit a safe and useful temperature of water to be drawn from the tank. (See Figure 9.)

b. **Size of Water Circulating Piping:** The size of the water circulating piping, in general, shall conform with the size of the water connections of the heater.

c. **Sediment Drain:** A suitable water valve or cock, through which sediment may be drawn off or the tank emptied, shall be installed at the bottom of the tank.

d. **Anti-Siphoning Devices:** Means acceptable to the authority having jurisdiction shall be provided to prevent siphoning in any boiler or tank to which any circulating water heater is attached. A cold water tube with a hole near the top is commonly accepted for this purpose. (See Figure 9.)

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*For details of protection, refer to Appendix E of the National Building Code (1976).

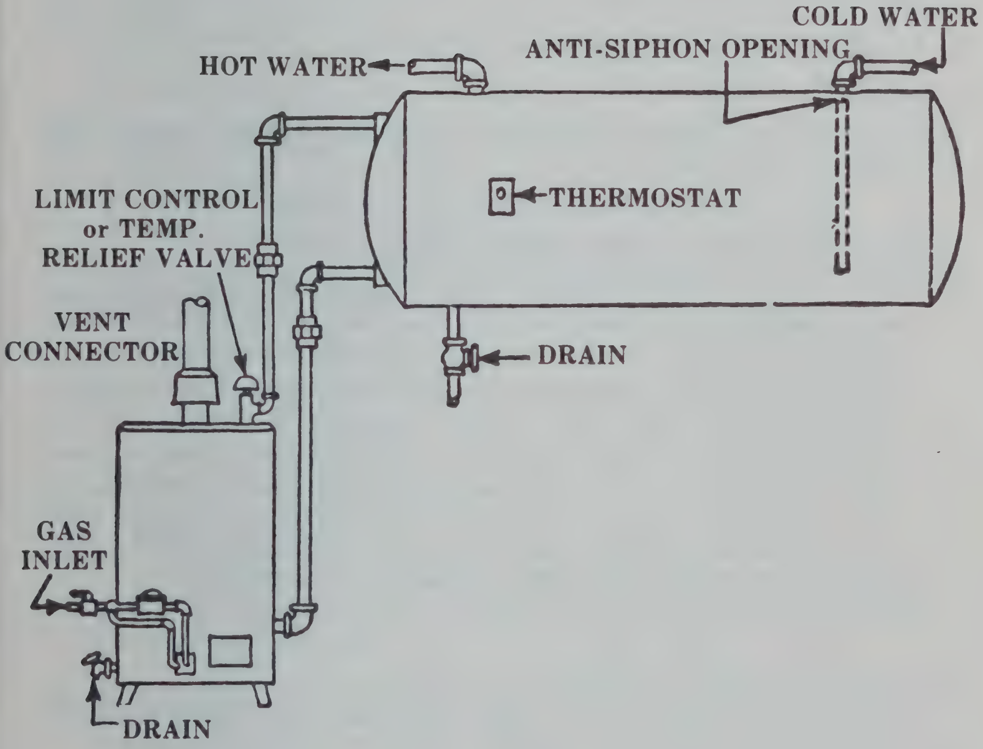

Fig. 9. Suggested Location for Anti-Siphon Opening in Cold Water Inlet.

PART 7

VENTING OF EQUIPMENT

7.1 Specification for Venting.

7.1.1 Connection to Venting Systems: Except as noted in 7.1.2, 7.1.3 and 7.1.4, all gas utilization equipment shall be connected to venting systems.

7.1.2 **Equipment Not Required to be Vented:**

a. Listed ranges.

b. Built-in domestic cooking units listed and marked for optional venting.

c. Listed hot plates and listed laundry stoves.

d. Listed Type 1 clothes dryers (see 6.4.4).

e.* A single listed booster type (automatic instantaneous) water heater when designed and used solely for the sanitizing rinse requirements of a National Sanitation Foundation Class 1, 2 or 3 dishwashing machine, provided that the input is limited to 50,000 Btu per hour, the storage capacity is limited to 12.5 gallons, and the heater is installed, with the draft hood in place and unaltered, in a commercial kitchen having a mechanical exhaust system. When installed in this manner, the draft hood outlet shall not be less than 36 inches vertically and 6 inches horizontally from any surface other than the heater.

f.* Listed refrigerators.

g.* Counter appliances.

h.* Room heaters listed for unvented use (see 6.23.1 and 6.23.2).

i.* Direct gas-fired make-up air heaters.

j.* Other equipment listed for unvented use and not provided with flue collars.

k.* Specialized equipment of limited input such as laboratory burners or gas lights.

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*Information on the construction and installation of ventilating hoods may be obtained from the Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, ANSI/NFPA 96.

*When any or all of this equipment is installed so the aggregate input rating exceeds 20 Btu per hour per cubic foot of room or space in which it is installed, one or more shall be provided with venting systems or other approved means for removing the vent gases to the outside atmosphere so the aggregate input rating of the remaining unvented equipment does not exceed the 20 Btu per hour per cubic foot figure. When the room or space in which the equipment is installed is directly connected to another room or space by a doorway, archway or other opening of comparable size which cannot be closed, the volume of such adjacent room or space may be included in the calculations.

7.1.3 **Ventilating Hoods:** Ventilating hoods and exhaust systems may be used to vent gas utilization equipment installed in commercial applications* and to vent industrial equipment, particularly when the process itself requires fume disposal (see 7.14.4).

7.1.4 **Well-Ventilated Spaces:** When located in a large and well-ventilated space, industrial gas utilization equipment may be operated by discharging the flue gases directly into the space.

7.2 Minimum Safe Performance.

7.2.1 Adequate Draft:

a. A venting system shall be designed and constructed so as to develop a positive flow adequate to remove flue or vent gases to the outside atmosphere.

b. A venting system serving gas utilization equipment requiring draft for proper operation shall be designed and installed to develop adequate draft so as to satisfy the draft requirements of the equipment in accordance with the manufacturer's instructions.

7.2.2 **Design and Construction:** Gas utilization equipment required to be vented shall be connected to a venting system designed and constructed in accordance with the provisions of 7.3 through 7.14.

7.2.3 **Circulating Air Ducts and Plenums:** No portion of a venting system shall extend into or pass through any circulating air duct or plenum.

7.3 Type of Venting System to be Used.

Venting systems are intended for venting flue gases at zero or negative pressures unless the venting system is made so as to prevent the leakage of vent gases into a building. (See 7.14.3-b.)

7.3.1 **Chimneys:** Chimneys shall be used for venting the following types of gas utilization equipment:

a. Incinerators, except as provided in 7.3.4-b and 7.14.2.

b. Equipment which may be converted to the use of solid or liquid fuels.

c. Combination gas- and oil-burning equipment.

d. Combination gas- and solid fuel-burning equipment.

e. Equipment listed for use with chimneys only.

f. Unlisted equipment.

7.3.2 **Type B Gas Vents:** Listed gas utilization equipment equipped with draft hoods and other equipment listed for use with Type B gas vents may be connected to Type B vents, except (1) as provided in 7.3.1, 7.3.3 and 7.3.7, and (2) commercial cooking equipment listed as "not suitable for connection to Type B gas vent."

7.3.3 **Type B-W Gas Vents:** Type B-W gas vents shall be used with listed vented wall furnaces when the furnace is so listed. Also see 6.28.

7.3.4 **Single Wall Metal Pipe:** Single-wall metal pipe may be used in accordance with 7.6 for venting the following:

a. Residential-type and low-heat gas utilization equipment equipped with draft hoods, except as provided in 7.3.1 and 7.3.3.

b. Incinerators used outdoors such as in open sheds, breezeways, or carports as provided in 7.6.3-c.

c. Gas-fired toilets. (See 6.26.3.)

7.3.5 **Type L Vents:** Type L vents may be used for venting gas utilization equipment listed for use with Type L vents and equipment listed as suitable for use with Type B gas vents.

7.3.6 **Plastic Piping:** Approved plastic piping may be used for venting equipment listed for use with such venting materials.

7.3.7 **Special Venting Arrangements:**

a. Direct vent equipment. (See 7.14.1.)

b. Equipment with integral vent. (See 7.14.2.)

c. Mechanical draft systems. (See 7.14.3.)

d. Ventilating hoods and exhaust systems. (See 7.14.4.)

e. Decorative appliances in vented fireplaces. (See 6.8.1-b.)

7.4 Masonry, Metal and Factory-Built Chimneys.

7.4.1 Listing or Construction:

a. Factory-built chimneys shall be installed in accordance with their listing and the manufacturer's instructions.

b. Masonry or metal chimneys shall be built and installed in accordance with nationally recognized building codes or standards.*

7.4.2 Termination:

a. A chimney for residential-type or low-heat gas utilization equipment shall extend at least 3 feet above the highest point where it passes through a roof of a building and at least 2 feet higher than any portion of a building within a horizontal distance of 10 feet. (See Figure 10.)

b. A chimney for medium-heat equipment shall extend at least 10 feet higher than any portion of any building within 25 feet.

c. A chimney shall extend at least 5 feet above the highest connected equipment draft hood outlet or flue collar.

7.4.3 Size of Chimneys:

a. The effective area of a chimney venting system shall be in accordance with approved engineering methods. The sizing of a chimney for natural draft venting of one or more listed appliances equipped with a draft hood or appliances listed for use with Type B vent, installed in a single story of a building, may be in accordance with Tables G-3 and G-6 of Appendix G. As an alternate method of sizing an individual chimney venting system for a single appliance only, the effective areas of the vent connector and chimney flue shall be not less than the area of the appliance draft hood or flue outlet. As an alternate method for sizing a chimney connected to more than one appliance, the effective area of the chimney flue shall be not less than the area of the largest vent connector plus 50 percent of the area of additional draft hood or flue outlets.

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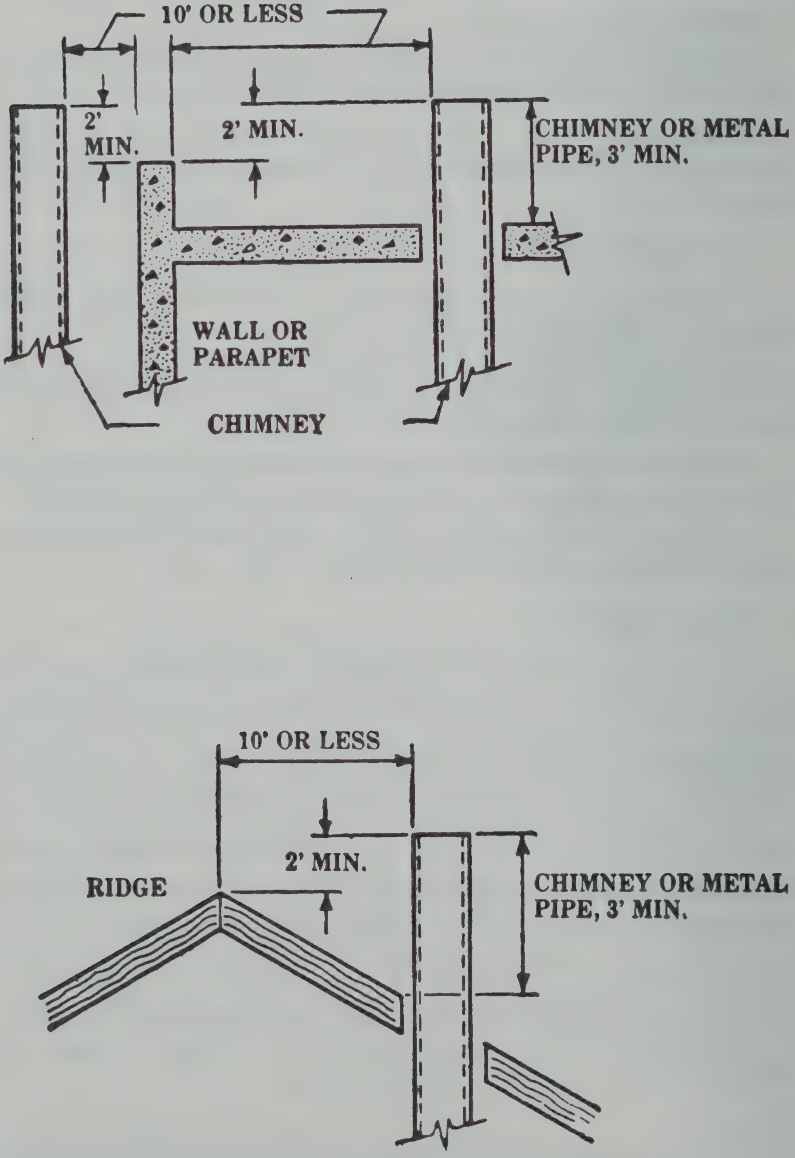
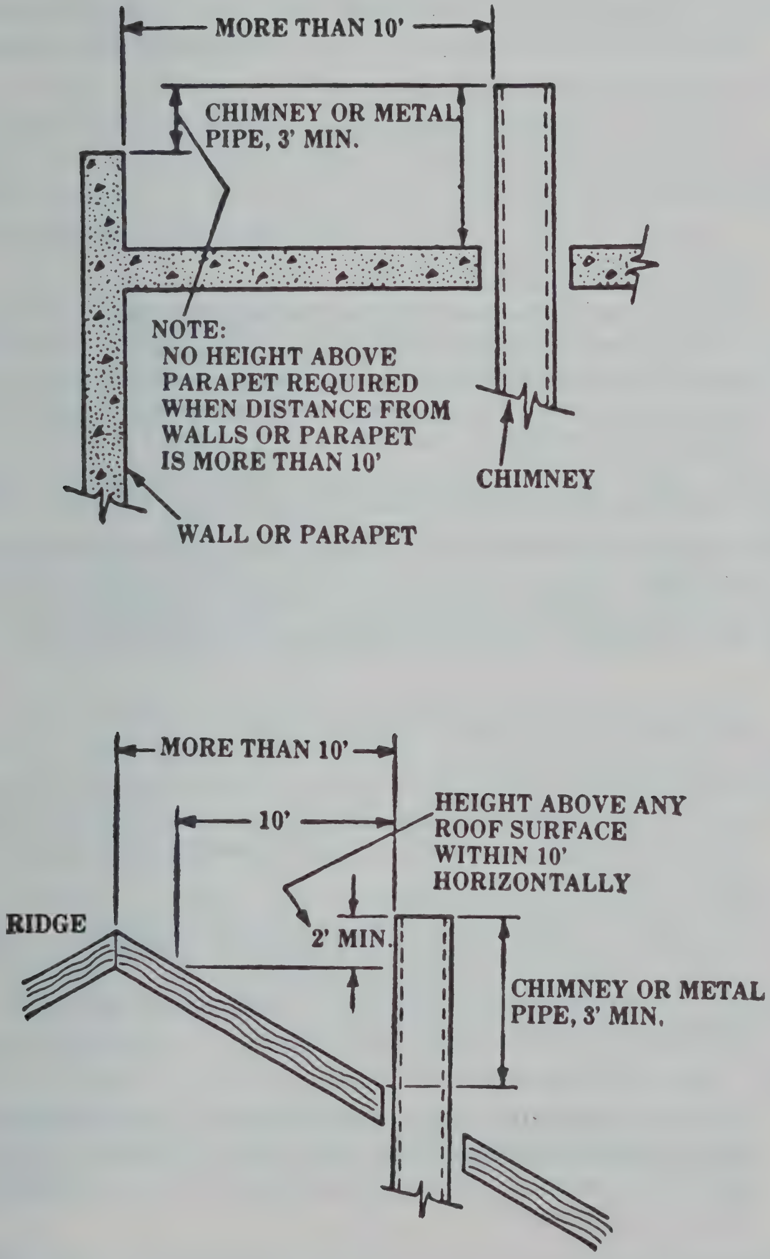
*Among such nationally recognized codes and standards are Article X of the National Building Code, or the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, ANSI/NFPA 211.

Fig. 10. Typical Termination Locations for Chimneys and Metal Pipes Serving Residential-Type and Low-Heat Equipment



A. Termination 10 Feet or Less From Ridge, Wall or Parapet

Fig. 10 (Continued)


MORE THAN 10'
CHIMNEY OR METAL PIPE, 3' MIN.
NOTE:
NO HEIGHT ABOVE PARAPET REQUIRED WHEN DISTANCE FROM WALLS OR PARAPET IS MORE THAN 10'
CHIMNEY
WALL OR PARAPET
MORE THAN 10'
10'
HEIGHT ABOVE ANY ROOF SURFACE WITHIN 10' HORIZONTALLY
RIDGE
2' MIN.
CHIMNEY OR METAL PIPE, 3' MIN.

B. Termination More Than 10 Feet From Ridge, Wall or Parapet

b. When an incinerator is vented by a chimney serving other gas utilization equipment, the gas input to the incinerator need not be included in calculating chimney size provided the chimney flue diameter is not less than one inch larger in equivalent diameter than the diameter of the incinerator flue outlet.

7.4.4 Inspection of Chimneys:

a. Before connecting a vent connector to a chimney, the chimney passageway shall be examined to ascertain that it is clear and free of obstructions.

b. Cleanouts shall be examined to determine they will remain tightly closed when not in use.

c. When inspection reveals that an existing chimney is not safe for the intended application, it shall be rebuilt to conform to nationally recognized standards,* lined or relined with a suitable liner, or replaced with a vent or chimney suitable for the equipment to be attached.

7.4.5 Chimney Serving Equipment Burning Other Fuels: See 7.9.4.

7.4.6 Support of Chimneys: All portions of chimneys shall be supported for the design and weight of the materials employed. Listed factory-built chimneys shall be supported and spaced in accordance with their listings and the manufacturer's instructions.

7.5 Type B, Type B-W and Type L Vents.

7.5.1 Application:

a. Type B, Type B-W and Type L vents shall be installed in accordance with the terms of their listings and the manufacturer's instructions.

b. A Type B-W vent shall have a listed capacity not less than that of the listed vented wall furnace to which it is connected.

c. A vent passing through a roof shall extend through the roof flashing, roof jack or roof thimble.

7.5.2 Vent Termination:

a. A vent shall terminate above the roof surface with a listed cap or listed roof assembly in accordance with the terms of their respective listings and the manufacturer's instructions, except as provided in 7.14.

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*Among such nationally recognized codes and standards are Article X of the National Building Code, or the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, ANSI/NFPA 211.

b. A vent may be connected to a chimney terminating in accordance with 7.4.2.

c. A Type B or a Type L vent shall terminate at least 5 feet in vertical height above the highest connected equipment draft hood or flue collar.

d. A Type B-W vent shall terminate at least 12 feet in vertical height above the bottom of the wall furnace.

e. A vent extending through an exterior wall shall not terminate adjacent to the wall or below eaves or parapets, except as provided in 7.14.1 and 7.14.3.

7.5.3 Size of Gas Vents: Venting systems shall be sized and constructed in accordance with approved engineering methods.* The sizing of natural draft venting systems serving one or more listed appliances equipped with a draft hood or appliances listed for use with Type B vent, installed in a single story of a building, may be in accorance with Tables G-1, G-2, G-4 and G-5 of Appendix G. As an alternate method for sizing an individual vent for a single appliance only, the effective area of the vent connector and vent shall be not less than the area of the appliance draft hood outlet. As an alternate method for sizing a vent connected to more than one appliance, the effective area of the vent shall be not less than the area of the largest vent connector plus 50 percent of the areas of additional draft hood outlets.

7.5.4 Vents Serving Equipment on More than One Floor: A single or common Type B or Type L vent is permissible in multistory installations to vent gas utilization equipment located on more than one floor level provided the venting system is designed and installed in accordance with approved engineering practices.

7.5.5 Support of Vents: Vents shall be supported and spaced in accordance with their listings and the manufacturer's instructions.

7.5.6 Marking: In those localities where solid and liquid fuels are used extensively, vents shall be plainly and permanently identified by a label attached to the wall or ceiling at a point where the vent connector enters the vent. The label shall read:

> "This gas vent is for appliances which burn gas. Do not connect to incinerators or solid or liquid fuel-burning appliances."

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*Reference may also be made to the chapter on chimney, gas vent and fireplace systems of the Equipment Volume of the ASHRAE Handbook.

The authority having jurisdiction shall determine whether its area constitutes such a locality.

7.6 Single-Wall Metal Pipe.

7.6.1 Construction: Single-wall metal pipe shall be constructed of galvanized sheet steel not less than 0.0304† inch thick, or other approved noncombustible corrosion-resistant material.

7.6.2 Termination:

a. Single-wall metal pipe shall terminate at least 5 feet in vertical height above the highest connected equipment draft hood outlet or flue collar.

b. Single-wall metal pipe shall extend at least 2 feet above the highest point where it passes through a roof of a building and at least 2 feet higher than any portion of a building within a horizontal distance of 10 feet. (See Figure 10.)

c. An approved cap which does not obstruct the pipe outlet shall be attached to the terminus of a single-wall metal pipe.

7.6.3 Installation With Equipment Permitted by 7.3.4:

a. Single-wall metal pipe shall be used only for runs directly from the space in which the gas utilization equipment is located through the roof or exterior wall to the outer air. A pipe passing through a roof shall extend without interruption through the roof flashing, roof jacket or roof thimble.

b. Single-wall metal pipe shall not originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall or concealed space, or through any floor. For the installation of a single-wall metal pipe through an exterior combustible wall, see 7.9.16-b.

c. Single-wall metal pipe used for venting an incinerator shall be exposed and readily examinable for its full length and suitable clearances maintained.

d. Minimum clearances from single-wall metal pipe to combustible material shall be in accordance with Table IX. The clearance from single-wall metal pipe to combustible material may be reduced when the combustible material is protected as specified for vent connectors in Table VI.

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†This corresponds to No. 20 Galvanized Sheet Gage number with all applicable minus tolerances included.

Table IX (See Note 1.)

Clearances for Connectors

Equipment	Minimum Distance from Combustible Material			
	Listed Type B Gas Vent Material	Listed Type L Vent Material	Single-Wall Metal Pipe	Factory-Built Chimney Sections
Listed equipment with draft hoods and equipment listed for use with Type B Gas Vents	as listed	as listed	6 inches	as listed
Residential boilers and furnaces with listed gas conversion burner and with draft hood	6 inches	6 inches	9 inches	as listed
Residential appliances listed for use with Type L vents	not permitted	as listed	9 inches	as listed
Residential incinerators	not permitted	9 inches	18 inches	as listed
Listed gas-fired toilets	not permitted	as listed	as listed	as listed
Unlisted residential appliances with draft hood	not permitted	6 inches	9 inches	as listed
Residential and low-heat equipment other than those above	not permitted	9 inches	18 inches	as listed
Medium-heat equipment	not permitted	not permitted	36 inches	as listed

1. These clearances shall apply unless the listing of an appliance specifies different clearances, in which case the listed clearances shall apply.

e. When a single-wall metal pipe passes through a roof constructed of combustible material, a noncombustible, nonventilating thimble shall be used at the point of passage. The thimble shall extend at least 18 inches above and 6 inches below the roof with the annular space open at the bottom and closed only at the top. The thimble shall be sized in accordance with 7.9.16-b.

7.6.4 Size of Single-Wall Metal Pipe:

a. A venting system of single-wall metal pipe shall be sized and constructed in accordance with approved engineering methods.* As an alternate method for sizing a venting system for a single appliance only, the effective area of the connector and the pipe shall not be less than the area of the appliance draft hood outlet. As an alternate method for sizing a venting system connected to more than one appliance, the effective area of the pipe shall be not less than the area of the largest connector plus 50 percent of the area of additional draft hood outlets. The sizing of single-wall metal pipe for natural draft venting of one or more listed appliances equipped with draft hoods or appliances listed for use with Type B vents, installed in a single room, may be in accordance with Tables G-2 and G-5 of Appendix G.

b. Any shaped single-wall metal pipe may be used, provided its equivalent effective area is equal to the effective area of the round pipe for which it is substituted and provided the minimum internal dimension of the pipe is not less than 2 inches.

c. The vent cap or a roof assembly shall have a venting capacity not less than that of the pipe to which it is attached.

7.6.5 Support of Single-Wall Metal Pipe: All portions of single-wall metal pipe shall be supported for the design and weight of the material employed.

7.6.6 Marking: Single-wall metal pipe shall comply with the marking provisions of 7.5.6.

7.7 Venting System Location.

a. A venting system shall terminate at least 3 feet above any forced air inlet located within 10 feet.

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*Reference may also be made to the chapter on chimney, gas vent and fireplace systems of the Equipment Volume of the ASHRAE Handbook.

b. The venting system of other than a direct vent appliance shall terminate at least 4 feet below, 4 feet horizontally from or 1 foot above any door, window or gravity air inlet into any building.

c. The vent terminal of a direct vent appliance with an input of 50,000 Btu per hour or less shall be located at least 9 inches from any opening through which flue gases could enter a building, and such an appliance with an input over 50,000 Btu per hour shall require a 12-inch vent termination clearance. The bottom of the vent terminal and the air intake shall be located at least 12 inches above grade.

7.8 Outside Vents and Chimneys.

7.8.1 Materials: Uninsulated single-wall metal pipe shall not be used outdoors in cold climates for venting gas utilization equipment with draft hoods.

7.8.2 Condensate Drain: When local experience indicates that condensate may be a problem, provision shall be made to drain off the condensate.

7.9 Vent Connectors.

7.9.1 When Required: A vent connector shall be used to connect gas utilization equipment to a gas vent, chimney or single-wall metal pipe, except when the gas vent, chimney or single-wall metal pipe is directly connected to the equipment.

7.9.2 Materials:

a. A vent connector shall be made of noncombustible corrosion-resistant material capable of withstanding the vent gas temperature produced by the gas utilization equipment and of sufficient thickness to withstand physical damage.

b. Vent connectors for residential-type appliances shall comply with the following:

1. Appliances Installed in Attics: Vent connectors for listed gas appliances having draft hoods and appliances listed for use with Type B vents, which are installed in attics, shall be of Type B or Type L vent material.
2. Appliances Not Installed in Attics: Vent connectors for listed gas appliances having draft hoods and for appliances having draft hoods and equipped with listed conversion burners, which are not installed in attics, shall be of Type B

or Type L vent material or metal pipe having resistance to heat and corrosion not less than that of galvanized sheet steel or aluminum not less than 0.016* inch thick.

Vent connectors for combination gas- and oil-burning appliances, residential incinerators and appliances other than those noted in "1" above, and which are not installed in attics, shall be of Type L vent material, factory-built chimney section or steel pipe having resistance to heat and corrosion not less than that of galvanized steel specified in Table X.

c. A vent connector for low-heat equipment shall be a factory-built chimney section or steel pipe having resistance to heat and corrosion equivalent to that for the appropriate galvanized pipe as specified in Table X. Factory-built chimney sections shall be joined together in accordance with the chimney manufacturer's instructions.

Table X

Minimum Thickness for Galvanized Steel Vent Connectors for Low-Heat Appliances

Diameter of Connector, Inches	Minimum Thickness, Inch*
less than 6	0.019 (26)
6 to less than 10	0.023 (24)
10 to 12 inclusive	0.029 (22)
14 to 16 inclusive	0.034 (20)
over 16	0.056 (16)

*The figures in parentheses are the corresponding Galvanized Sheet Gage number with all applicable minus tolerances included.

d. Vent connectors for medium-heat equipment and commercial and industrial incinerators shall be constructed of factory-built medium-heat chimney sections or steel of a thickness not less than specified in Table XI, and shall comply with the following:

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*This corresponds to No. 28 Galvanized Sheet Gage number with all applicable minus tolerances included.

1. A steel vent connector for equipment with a vent gas temperature in excess of 1000 F, measured at the entrance to the connector, shall be lined with medium duty fire brick (ASTM C64, Type F), or the equivalent.
2. The lining shall be at least 2½ inches thick for a vent connector having a diameter or greatest cross-section dimension of 18 inches or less.
3. The lining shall be at least 4½ inches thick laid on the 4½-inch bed for a vent connector having a diameter or greatest cross-section dimesion greater than 18 inches.
4. Factory-built chimney sections, if employed, shall be joined together in accordance with the chimney manufacturer's instructions.

7.9.3 Size of Vent Connector:

a. A vent connector for gas utilization equipment with a single draft hood shall be sized and constructed in accordance with approved engineering practices. Reference may be made to Tables G-1 through G-3 in Appendix G, depending on the construction of the connector.* As an alternate method the effective area of the connector shall be not less than the area of the draft hood outlet.

Table XI

Minimum Thickness for Steel Vent Connectors for Medium Heat Equipment and Commercial and Industrial Incinerators

Vent Connector Size		Minimum Thickness, Inch*
Diameter, In.	Area, Sq. In.	
up to 14	up to 154	0.053 (16)
over 14 to 16	154 to 201	0.067 (14)
over 16 to 18	201 to 254	0.093 (12)
over 18	Larger than 254	0.123 (10)

*The figures in parentheses are the corresponding Manufacturer's Standard Gage number with all applicable minus tolerances included.

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*Reference may also be made to the chapter on chimney, gas vent and fireplace systems of the Equipment Volume of the ASHRAE Handbook.

b. For a single appliance having more than one draft hood outlet, the manifold shall be constructed according to the instructions of the appliance manufacturer. If there are no instructions, the manifold shall be designed and constructed in accordance with approved engineering practices. As a second alternate, the effective area of the manifold shall equal the combined areas of the draft hood outlets.

c. When two or more gas appliances are connected to a common vent or chimney, the effective area of each vent connector shall be in accordance with approved engineering practices. Reference may be made to Tables G-4 through G-6 in Appendix G.* As an alternate method, each vent connector shall have an effective area not less than the area of the draft hood outlet of the appliance to which it is connected.

d. When two or more gas appliances are vented through a common vent connector or manifold, the common vent connector or manifold shall be located at the highest level consistent with available headroom or clearance to combustible material. The effective area of the common vent connector or manifold and all junction fittings shall be not less than the area of the largest vent connector plus 50 percent of the areas of additional draft hood outlets.

e. When the size of a vent connector is increased to overcome installation limitations and obtain connector capacity equal to the equipment input, the size increase shall be made at the equipment draft hood outlet.

f. The effective area of the vent connector, when connected to one or more appliances requiring draft for operation, shall be obtained by the application of approved engineering practices to perform as specified in 7.2.1.

7.9.4 Two or More Appliances Connected to a Single Vent:

a. Gas utilization equipment shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel.

b. Gas utilization equipment and equipment burning liquid fuel may be connected to one chimney flue through separate openings or may be connected through a single opening if joined by a suitable fitting located as close as practical to the chimney. If two or more openings are provided into one chimney flue, they shall be at different levels. If the gas utilization equipment is automatically controlled, it shall be equipped with a safety shutoff device.

c. When two or more vent connectors enter a common gas vent, chimney flue or single-wall metal pipe, the smaller connector shall enter at the highest level consistent with the available headroom or clearance to combustible material.

7.9.5 Combination Units:

a. A listed combination gas- and solid fuel-burning appliance equipped with a manual reset device to shut off gas to the main burner in the event of sustained backdraft or flue gas spillage may be connected to a single chimney flue. The chimney flue shall be sized to properly vent the appliance.*

b. A listed combination gas- and oil-burning appliance may be connected to a single chimney flue. The chimney flue shall be sized to properly vent the appliance.*

7.9.6 Clearance: Minimum clearances from vent connectors to combustible material shall be in accordance with Table IX, except that the clearance between a vent connector and combustible material may be reduced when the combustible material is protected as specified for vent connectors in Table VI.

7.9.7 Avoid Unnecessary Bends: A vent connector shall be installed so as to avoid turns or other construction features which create excessive resistance to flow of vent gases.

7.9.8 Joints: Vent connectors shall be firmly attached to draft hood outlets or flue collars by sheet-metal screws or other approved means, except vent connectors of listed Type B or Type L vent material which shall be assembled in accordance with the manufacturer's instructions. Joints between sections of connector piping shall be fastened by sheet-metal screws or other approved means.

7.9.9 Slope: A vent connector shall be installed without any dips or sags and shall slope upward at least ¼ inch per foot.

7.9.10 Length of Vent Connector:

a. A vent connector shall be as short as possible and the gas utilization equipment located as close as practicable to the chimney or vent.

b. Except when part of a designed venting system, the horizontal run of an uninsulated vent connector to a natural draft chimney or vent serving a single appliance shall not be more than 75 percent of the height of the vertical portion of the chimney or vent above the connector.

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*Reference may also be made to the chapter on chimney, gas vent and fireplace systems of the Equipment Volume of the ASHRAE Handbook.

c. Except when part of a designed venting system, the horizontal run of an insulated vent connector to a natural draft chimney or vent serving a single gas or liquid fuel-fired appliance shall not be more than 100 percent of the height of the vertical portion of the chimney or vent above the connector.

7.9.11 **Support:** A vent connector shall be supported for the design and weight of the material employed to maintain clearances and prevent physical damage and separation of joints.

7.9.12 **Location:** When the vent connector used for gas utilization equipment having a draft hood must be located in or pass through a crawl space or other area which may be cold, that portion of the vent connector shall be of listed double-wall Type B or Type L vent material or material having equivalent insulation qualities.

7.9.13 **Chimney Connection:** In entering a passageway in a masonry or metal chimney, the vent connector shall be installed above the extreme bottom to avoid stoppage. A thimble or slip joint may be used to facilitate removal of the connector. The connector shall be firmly attached to or inserted into the thimble or slip joint to prevent the connector from falling out. Means shall be employed which will prevent the connector from entering so far as to restrict the space between its end and the opposite wall of the chimney.

7.9.14 **Inspection:** The entire length of a vent connector shall be readily accessible for inspection, cleaning and replacement.

7.9.15 **Fireplaces:** A vent connector shall not be connected to a chimney flue serving a fireplace unless the fireplace flue opening is permanently sealed.

7.9.16 **Passage Through Ceilings, Floors or Walls:**

a. A vent connector shall not pass through any ceiling, floor, fire wall or fire partition. A single-wall metal pipe connector shall not pass through any interior wall.

b. A vent connector made of a single-wall metal pipe shall not pass through a combustible exterior wall unless guarded at the point of passage by a ventilated metal thimble not smaller than the following:

1. For listed gas utilization equipment equipped with draft hoods and equipment listed for use with Type B vents, 4 inches larger in diameter than the vent connector. When there is a run of not less than 6 feet of vent connector in the

open between the draft hood outlet and the thimble, the thimble may be 2 inches larger in diameter than the vent connector.

2. For unlisted equipment having draft hoods, 6 inches larger in diameter than the vent connector.

3. For residential incinerators and all other residential and low-heat equipment, 12 inches larger in diameter than the vent connector.

In lieu of thimble protection, all combustible material in the wall may be cut away from the vent connector a sufficient distance to provide the specified clearance from such vent connector to combustible material. Any material used to close up such opening shall be noncombustible.

c. Except as provided in "a" above, vent connectors made of listed Type B or Type L vent material and serving listed equipment with draft hoods and other equipment listed for Type B vents may pass through walls or partitions constructed of combustible material if the connectors are installed with not less than the listed clearance to combustible material.

d. Vent connectors for medium-heat equipment shall not pass through walls or partitions constructed of combustible material.

7.10 Draft Hoods and Draft Controls.

7.10.1 Equipment Requiring Draft Hoods: Vented gas utilization equipment shall be installed with draft hoods except dual oven type combination ranges, incinerators, direct vent equipment, equipment requiring chimney draft for operation, single firebox boilers equipped with conversion burners with inputs greater than 400,000 Btu per hour, equipment equipped with blast, power or pressure burners which are not listed for use with draft hoods, and equipment designed for forced venting.

7.10.2 Installation:

a. Except as noted in "b" below, a draft hood supplied with or forming a part of listed vented gas utilization equipment shall be installed without alteration, exactly as furnished and specified by the equipment manufacturer. If a draft hood is not supplied by the equipment manufacturer when one is required, a draft hood shall be installed, be of a listed or approved type and, in the absence of other instructions, be of the same size as the equipment flue collar. When a draft hood is required with a conversion burner, it shall be of a listed or approved type.

b. If it is determined that a draft hood of special design is needed or preferable for a particular installation, the advice of the gas utilization equipment manufacturer and the approval of the authority having jurisdiction shall be secured.

7.10.3 **Draft Control Devices:** When a draft control device is part of the gas utilization equipment or is supplied by the equipment manufacturer, it shall be installed without alteration in accordance with the manufacturer's instructions. In the absence of manufacturer's instructions, the device shall be attached to the flue collar of the equipment or as near to the equipment as conditions permit.

7.10.4 **Additional Devices:** Gas utilization equipment (except incinerators) requiring controlled chimney draft may be equipped with a listed double acting barometric draft regulator installed and adjusted in accordance with the manufacturer's instructions. Figure 11 shows examples of correct and incorrect locations for barometric draft regulators. A device which will automatically shut off gas to the burner in the event of sustained backdraft is recommended if such backdraft might adversely affect burner operation or if flue gas spillage might introduce a hazard.

7.10.5 **Incinerator Draft Regulator:** A listed gas-fired incinerator may be equipped with a listed single acting barometric draft regulator when recommended by the incinerator manufacturer. This draft regulator shall be installed in accordance with the instructions accompanying the incinerator.

7.10.6 **Install In Same Room:** A draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment in such a manner as to prevent any difference in pressure between the hood or regulator and the combustion air supply.

7.10.7 **Positioning:** A draft hood or draft regulator shall be installed in the position for which it was designed with reference to the horizontal and vertical planes and shall be located so that the relief opening is not obstructed by any part of the gas utilization equipment or adjacent construction. The equipment and its draft hood shall be located so that the relief opening is accessible for checking vent operation.

7.10.8 **Clearance:** A draft hood shall be located so its relief opening is not less than 6 inches from any surface except that of the gas utilization equipment it serves and the venting system to which the draft hood is connected. When a greater or lesser clearance is indicated on the equipment label, the clearance shall not be less than that specified on the label. These clearances shall not be reduced.

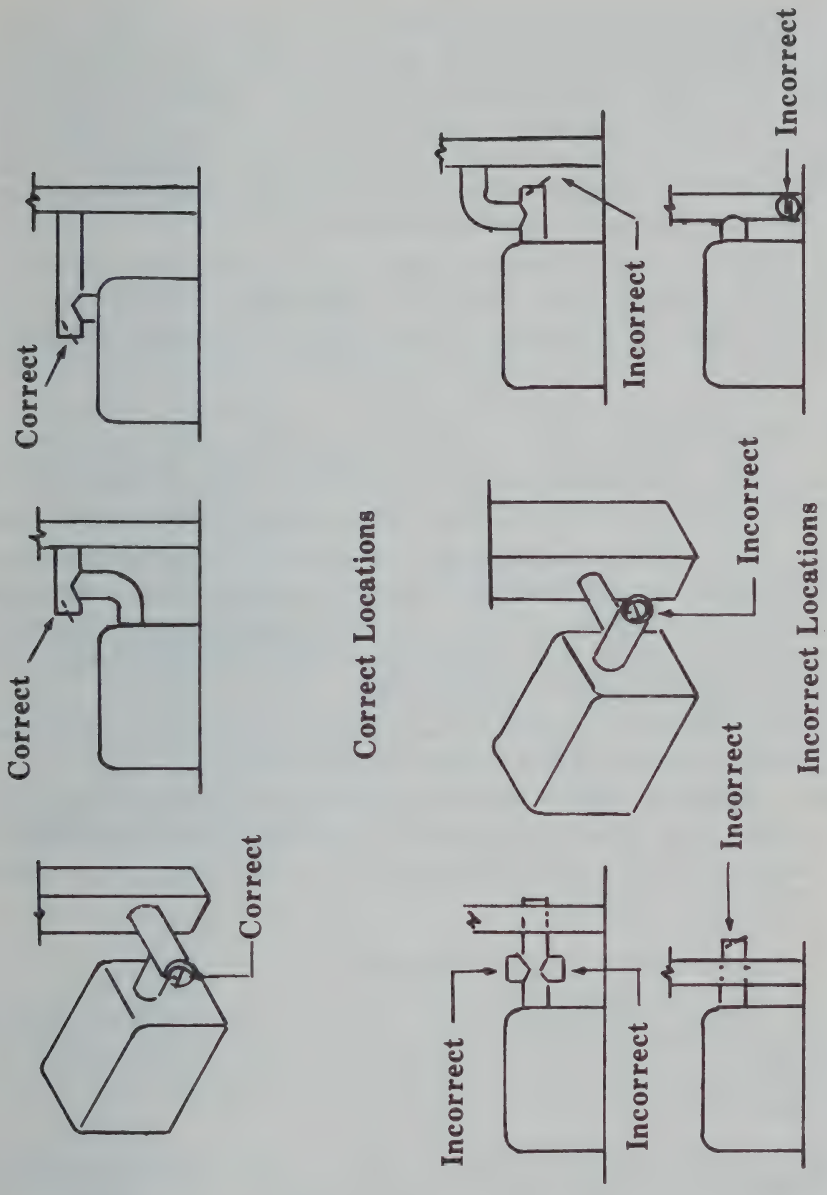

Fig. 11 Locations for Barometric Draft Regulator

7.11 Manually Operated Dampers.

A manually operated damper shall not be placed in the vent connector from any gas utilization equipment, except in a connector serving a listed gas-fired incinerator when recommended by the incinerator manufacturer and installed in accordance with the instructions accompanying the incinerator. Fixed baffles are not classified as manually operated dampers.

7.12 Automatically Operated Vent Dampers.

An automatically operated vent damper shall be of a listed type. Also see 9.3.

7.13 Obstructions.

Except as noted below, a device which will retard the flow of vent gases shall not be installed in a vent connector, chimney or vent.

a. Draft regulators and safety controls; (1) specifically listed for installation in venting systems and installed in accordance with the terms of their listing, and (2) designed and installed in accordance with approved engineering methods and approved by the authority having jurisdiction.

b. Listed automatically operated vent dampers installed in accordance with the terms of their listing.

c. Approved economizers, heat reclaimers and recuperators installed in venting systems of equipment not required to be equipped with draft hoods provided performance in accordance with 7.2.1 is obtained.

7.14 Special Venting Arrangements.

7.14.1 Direct Vent Equipment: Listed direct vent gas utilization equipment shall be considered properly vented when installed in accordance with the terms of its listing, the manufacturer's instructions and 7.7-c.

7.14.2 Equipment With Integral Vents: Gas utilization equipment incorporating integral venting means shall be considered properly vented when installed in accordance with its listing, the manufacturer's instructions and 7.7-a and -b.

7.14.3 Mechanical Draft Systems:

a. Gas utilization equipment, except incinerators, requiring venting may also be vented by means of mechanical draft systems of either forced or induced draft design.

b. Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to prevent leakage of flue or vent gases into a building.

c. Vent connectors serving equipment vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure.

d. When a mechanical draft system is employed, provision shall be made to prevent the flow of gas to the main burners when the draft system is not performing so as to satisfy the operating requirements of the equipment for safe performance.

e. The exit terminals of mechanical draft systems shall be not less than 7 feet above grade when located adjacent to public walkways and shall be located as specified in 7.7-a and -b.

7.14.4 Ventilating Hoods and Exhaust Systems:*

a. Ventilating hoods and exhaust systems may be used to vent gas utilization equipment installed in commercial applications.

b. When automatically operated gas utilization equipment is vented through a ventilating hood or exhaust system equipped with a damper or with a power means of exhaust, the gas utilization equipment control system shall be interlocked so as to permit the equipment firing only when the damper is open to a position to properly vent the equipment and when the power means of exhaust is in operation.

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*Information on the construction and installation of ventilating hoods may be obtained from the Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commerical Cooking Equipment, ANSI/NFPA 96.

PART 8

PROCEDURES TO BE FOLLOWED TO PLACE EQUIPMENT IN OPERATION

8.1 Adjusting the Burner Input.

8.1.1 **Burner Input:** Each burner shall be adjusted to its proper input in accordance with the manufacturer's instructions. Overheating of burners is prohibited.

8.1.2 **High Altitude:** Ratings of gas utilization equipment are based on sea level operation and need not be changed for operation at elevations up to 2,000 feet. For operation at elevations above 2,000 feet and, in the absence of specific recommendations from the local authority having jurisdiction, equipment ratings shall be reduced at the rate of 4 percent for each 1,000 feet above sea level before selecting appropriately sized equipment.

8.1.3 **Checking Burner Input:**

a. **Checking Burner Input Using a Meter:** To check the Btu input rate, the test hand on the meter should be timed for at least one revolution and the input determined from this timing. Test dials are generally marked ½, 1, 2 or 5 cubic feet per revolution depending upon the size of the meter. Instructions for converting the test hand readings to cubic feet per hour are given in Table XII.

b. **Checking Burner Input Not Using a Meter:** The fixed orifice size for each burner may be determined in accordance with Table F-1 for utility gases and Table F-2 for undiluted liquefied petroleum gases in Appendix F.

8.1.4 **Adjusting Input:** The input rate shall be adjusted to the proper rate by changing a fixed orifice size, changing the adjustment of an adjustable orifice, or by readjustment of the gas pressure regulator outlet pressure (when a regulator is provided). Consult the serving gas supplier.

8.2 Primary Air Adjustment.

The primary air for injection (Bunsen) type burners shall be adjusted for proper flame characteristics in accordance with the manufacturer's instructions. Normally, the primary air adjustment should first be set to give a soft blue flame having luminous tips and then increased to a point where the yellow tips just disappear. If the burner cannot be adjusted as above, consult the manufacturer or serving gas supplier. After setting the primary air, the adjustment means shall be secured in position.

8.3 Safety Shutoff Devices.

When a safety shutoff device is provided, it shall be checked for proper operation and adjustment in accordance with the manufacturer's instructions. If the device does not function properly to turn off the gas supply in the event of pilot outage, it shall be properly serviced or replaced with new equipment.

8.4 Automatic Ignition.

Gas utilization equipment supplied with means for automatic ignition shall be checked for proper operation. If necessary, proper adjustments shall be made.

8.5 Protective Devices.

All protective devices furnished with the gas utilization equipment, such as a limit control, fan control to blower, temperature and pressure relief valve, low water cutoff device, manual operating features, etc., shall be checked for proper operation.

8.6 Checking the Draft.

Vent connected gas utilization equipment shall be operated for several minutes and checked to see that the combustion products are going up the chimney, or gas vent, properly by passing a lighted match or taper around the edge of the relief opening of the draft hood. If the chimney or gas vent is drawing properly, the match flame will be drawn into the draft hood. If not, the combustion products will tend to extinguish this flame. If the combustion products are escaping from the relief opening of the draft hood, the equipment shall not be operated until proper adjustments or repairs are made to provide adequate draft through the chimney or gas vent.

8.7 Operating Instructions.

Operating instructions shall be furnished and shall be left in a prominent position near the equipment for the use of the consumer.

TABLE XII

Gas Input to Burner in Cubic Feet Per Hour

Seconds For One Revolution	Size of Test Meter Dial			
	One-Half Cu. Ft.	One Cu. Ft.	Two Cu. Ft.	Five Cu. Ft.
	Cubic Feet Per Hour			
10	180	360	720	1,800
11	164	327	655	1,636
12	150	300	600	1,500
13	138	277	555	1,385
14	129	257	514	1,286
15	120	240	480	1,200
16	112	225	450	1,125
17	106	212	424	1,059
18	100	200	400	1,000
19	95	189	379	947
20	90	180	360	900
21	86	171	343	857
22	82	164	327	818
23	78	157	313	783
24	75	150	300	750
25	72	144	288	720
26	69	138	277	692
27	67	133	267	667
28	64	129	257	643
29	62	124	248	621
30	60	120	240	600
31	58	116	232	581
32	56	113	225	563
33	55	109	218	545
34	53	106	212	529
35	51	103	206	514
36	50	100	200	500
37	49	97	195	486
38	47	95	189	474
39	46	92	185	462
40	45	90	180	450
41	44	88	176	440
42	43	86	172	430
43	42	84	167	420
44	41	82	164	410
45	40	80	160	400
46	39	78	157	391
47	38	77	153	383
48	37	75	150	375
49	37	73	147	367

NOTE: To convert to Btu per hour multiply by the Btu heating value of the gas used.

TABLE XII (Continued)

Gas Input to Burner in Cubic Feet Per Hour

Seconds For One Revolution	One-Half Cu. Ft.	One Cu. Ft.	Two Cu. Ft.	Five Cu. Ft.
	Size of Test Meter Dial — Cubic Feet Per Hour			
50	36	72	144	360
51	35	71	141	353
52	35	69	138	346
53	34	68	136	340
54	33	67	133	333
55	33	65	131	327
56	32	64	129	321
57	32	63	126	316
58	31	62	124	310
59	30	61	122	305
60	30	60	120	300
62	29	58	116	290
64	29	56	112	281
66	29	54	109	273
68	28	53	106	265
70	26	51	103	257
72	25	50	100	250
74	24	48	97	243
76	24	47	95	237
78	23	46	92	231
80	22	45	90	225
82	22	44	88	220
84	21	43	86	214
86	21	42	84	209
88	20	41	82	205
90	20	40	80	200
94	19	38	76	192
98	18	37	74	184
100	18	36	72	180
104	17	35	69	173
108	17	33	67	167
112	16	32	64	161
116	15	31	62	155
120	15	30	60	150
130	14	28	55	138
140	13	26	51	129
150	12	24	48	120
160	11	22	45	112
170	11	21	42	106
180	10	20	40	100

NOTE: To convert to Btu per hour multiply by the Btu heating value of the gas used.

* 8.8 Notification of Completion.

When regulations so require, the serving gas supplier or the authority having jurisdiction shall be notified that the installation has been completed.

PART 9

MODIFICATIONS TO EXISTING APPLIANCE INSTALLATIONS FOR THE PURPOSE OF FUEL CONSERVATION

9.1 Safety Inspection.

Prior to attempting any modification, a safety inspection of the existing appliance installation shall be performed by a qualified agency performing the modification. See Appendix H for a recommended procedure for such a safety inspection.

9.2 Reduction of Vent Connector Size.

If an existing vent connector is determined to be oversized for the input rate of the connected appliance, it may be resized in accordance with 7.9.3.

9.3 Automatic Vent Damper Device Installation.

A listed automatic vent damper device may be installed on an existing appliance installation provided the appliance is listed and equipped with a draft hood and provided the device is installed by a qualified agency (see 1.4) in accordance with the terms of its listing. The name of the installer and date of installation shall be marked on a label affixed to the damper device. For recommended procedures for installing automatic vent damper devices on existing appliance installations, see Appendices I, J and K.

PART 10

DEFINITIONS

Accessible. Having access to but which first may require the removal of a panel, door or similar covering of the item described.

Air, Circulating. Air for cooling, heating or ventilation distributed to habitable spaces.

Air Conditioning. The treatment of air so as to control simultaneously its temperature, humidity, cleanness and distribution to meet the requirements of a conditioned space.

Air Mixer. That portion of an injection (Bunsen) type burner into which the primary air is introduced.

Air Shutter. An adjustable device for varying the size of the primary air inlet(s).

Ambient Temperature. The temperature of the surrounding medium, usually used to refer to the temperature of the air in which a structure is situated or a device operates.

Appliance (Equipment). Any device which utilizes gas as a fuel or raw material to produce light, heat, power, refrigeration or air conditioning.

Appliance — Automatically Controlled. Appliances equipped with an automatic burner ignition and safety shutoff device and other automatic devices which:

a. Accomplish complete turn-on and shutoff of the gas to the main burner or burners.

b. Graduate the gas supply to the burner or burners, but do not effect complete shutoff of the gas.

Appliance, Building Heating. Fuel-gas burning boilers operating at not over 50 psig pressure, central furnaces and heaters intended primarily for heating spaces having volumes exceeding 25,000 cubic feet.

Appliance, Low-Heat. An appliance such as a commercial cooking range, pressing machine boiler at any pressure, bake oven, candy furnace, sterotype furnace, drying and curing appliance, and other process appliances in which materials are heated or melted at temperatures (excluding flue-gas temperatures) not exceeding 600 F.

Appliance, Medium-Heat. An industrial appliance such as an annealing furnace (glass or metal), charcoal furnace, galvanizing furnace, gas producer, commercial or industrial incinerator, and steam boiler operating at over 50 psig pressure when such appliance is larger than 100 cubic feet in size, and other furnaces classified as medium-heat appliances in accordance with nationally recognized good practice. Appliances otherwise classed as medium-heat appliances may be considered as low-heat appliances if not larger than 100 cubic feet in size, excluding any burner equipment and blower compartment.

Appliance, Residential-Type Heating. Fuel-gas burning heating appliances, except high-pressure steam boilers, for heating building spaces having a volume of not more than 25,000 cubic feet, and other heat producing appliances of the type mainly used in residences, such as cooking stoves and ranges, clothes dryers, fireplace stoves, domestic incinerators, laundry stoves, water heaters and heat pumps.

Approved. Acceptable to the authority having jurisdiction.

Atmospheric Pressure. The pressure of the weight of air and water vapor on the surface of the earth, approximately 14.7 pounds per square inch (psi) at sea level.

Authority Having Jurisdiction. The organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in this standard in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local, or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his delegated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Automatic Damper Regulator. A mechanically or electrically actuated device designed to maintain a constant draft on combustion equipment.

Automatic Firecheck. A device for stopping the progress of a flame front in burner mixture lines (flashback) and for automatically shutting off the fuel-air mixture.

Present units are customarily equipped with spring or weight loaded valves released for closure by a fusible link or by movement of bimetallic elements; they are also equipped with metallic screens for stopping the progress of a flame front.

Automatic Gas Shutoff Device. A device constructed so that the attainment of a water temperature in a hot water supply system in excess of some predetermined limit acts in such a way as to cause the gas to the system to be shut off.

Automatic Ignition. Ignition of gas at the burner(s) when the gas controlling device is turned on, including reignition if the flames on the burner(s) have been extinguished by means other than by the closing of the gas controlling device.

Backfire Preventer. (See Safety Blowout.)

Back Pressure. Pressure against which a fluid is flowing, resulting from friction in lines, restrictions in pipes, valves, pressure in vessel to which fluid is flowing, hydrostatic head, or other impediment that causes resistance to fluid flow.

Baffle. An object placed in an appliance to change the direction of, or retard, the flow of air, air-gas mixtures, or flue gases.

Barometric Draft Regulator. A balanced damper device attached to a chimney, vent connector, breeching or flue gas manifold to protect combustion equipment by controlling chimney draft. A double acting barometric draft regulator is one whose balancing damper is free to move in either direction to protect combustion equipment from both excessive draft and backdraft.

Boiler, Low-Pressure. A self-contained gas-burning appliance for supplying steam or hot water.

a. Hot Water Heating Boiler. A boiler in which no steam is generated, from which hot water is circulated for heating purposes and then returned to the boiler, and which operates at water pressures not exceeding 160 psig and at water temperatures not exceeding 250 F at or near the boiler outlet.

b. Hot Water Supply Boiler. A boiler, completely filled with water, which furnishes hot water to be used externally to itself, and which operates at water pressures not exceeding 160 psig and at water temperatures not exceeding 250 F at or near the boiler outlet.

c. Steam Heating Boiler. A boiler in which steam is generated and which operates at a steam pressure not exceeding 15 psig.

Branch Line. Gas piping which conveys gas from a supply line to the appliance.

Breeching. See Vent Connector.

Broiler. A general term including broilers, salamanders, barbecues, and other devices cooking primarily by radiated heat, excepting toasters.

Btu. Abbreviation for British Thermal Unit which is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Burner. A device for the final conveyance of the gas, or a mixture of gas and air, to the combustion zone.

a. Forced-Draft Burner. (See Power Burner.)

b. Induced-Draft Burner. A burner which depends on the draft induced by a fan beyond the appliance for its proper operation.

c. Injection (Bunsen) Type Burner. A burner employing the energy of a jet of gas to inject air for combustion into the burner and mix it with the gas.
   1. Atmospheric Injection Type Burner. A burner in which the air at atmospheric pressure is injected into the burner by a jet of gas.

d. Luminous or Yellow-Flame Burner. A burner in which secondary air only is depended on for combustion of the gas.

e. Power Burner. A burner in which either gas or air or both are supplied at a pressure exceeding, for gas, the line pressure, and for air, atmospheric pressure; this added pressure being applied at the burner. A burner for which air for combustion is supplied by a fan ahead of the appliance is commonly designated as a forced-draft burner.
   1. Premixing Burner. A power burner in which all or nearly all of the air for combustion is mixed with the gas as primary air.

Carbon Steel. By common custom, steel is considered to be carbon steel when no minimum content is specified or required for aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium or zirconium, or any other element added to obtain a desired alloying effect; when the specified minimum for copper does not exceed 0.40 percent; or when the maximum content specified for any of the following elements does not exceed the percentages noted: manganese 1.65, silicon 0.60, copper 0.60.

Central Premix System. A system which distributes flammable gas-air mixtures to two or more remote stations and is employed to provide one or more of the following:

a. Wide in-plant distribution of a centrally controlled gas-air mixture.

b. A wider range of mixture pressures (frequently in the 1 to 5 psig range) than available from other gas-air mixing equipment.

c. Close control of gas-air ratios over a wide turndown range (often 20 to 1 or more).

d. Ability to change total connected burner port area without installing new mixing devices or inserts.

Central premix systems may either proportion the flows of pressurized air and pressurized gas for subsequent mixing in a downstream tee or comparable fitting, or they may draw room air at essentially atmospheric pressure through a proportioning mixing valve and then through a blower or compressor downstream.

Chimney. (See also "Gas Vent," "Vent" and "Venting System.") One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outside atmosphere.

a. Factory-Built Chimney. A chimney composed of listed factory-built components assembled in accordance with the terms of their listing to form the completed chimney.

b. Masonry Chimney. A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units or reinforced portland cement concrete, lined with suitable chimney flue liners.

c. Metal Chimney. A field-constructed chimney of metal.

Clearing. The act of replacing one atmosphere with another by direct displacement so rapidly as to cause a minimum of mixing between the two atmospheres. By this means duration of any explosive mixture is reduced to a minimum, the gases are vented into a large open area high (8 feet or more) aboveground, and means of ignition are excluded.

Closed Water Piping System. A system of water piping where a check valve or other device prevents the free return of water or steam to the water main.

Clothes Dryer. A device used to dry wet laundry by means of heat derived from the combustion of fuel gases. Dryer classifications are as follows:

a. Type 1. Factory-built package, multiple produced. Primarily used in family living environment. May or may not be coin-operated for public use. Usually the smallest unit physically and in function output.

b. Type 2. Factory-built package, multiple produced. Used in business with direct intercourse of the function with the public. May or may not be operated by public or hired attendant. May or may not be coin-operated. Not designed for use in individual family living environment. May be small, medium or large in relative size.

Combustible Material. As pertaining to materials adjacent to or in contact with heat producing appliances, vent connectors, gas vents, chimneys, steam and hot water pipes, and warm air ducts, shall mean materials made of or surfaced with wood, compressed paper, plant fibers, or other materials that are capable of being ignited and burned. Such material shall be considered combustible even though flame-proofed, fire-retardant treated, or plastered.

Combustion. As used herein, the rapid oxidation of fuel gases accompanied by the production of heat, or heat and light. Complete combustion of a fuel is possible only in the presence of an adequate supply of oxygen.

Combustion Chamber. The portion of an appliance within which combustion occurs.

Combustion Products. Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inerts but excluding excess air.

Concealed Gas Piping. Gas piping, which, when in place in a finished building, would require removal of permanent construction to gain access to the piping.

Condensate (Condensation). The liquid which separates from a gas (including flue gas) due to a reduction in temperature or increase in pressure.

Consumption. The maximum amount of gas per unit of time, usually expressed in cubic feet per hour, or Btu per hour, required for the operation of the appliance or appliances supplied.

Control Piping. All piping, valves and fittings used to interconnect air, gas, or hydraulically operated control apparatus or instrument transmitters and receivers.

Controls. Devices designed to regulate the gas, air, water or electrical supply to a gas appliance. These may be manual or automatic.

Conversion Burner, Gas. A unit consisting of a burner and its controls utilizing gaseous fuel for installation in an appliance originally utilizing another fuel.

a. Firing Door Type. A conversion burner specifically for boiler or furnace firing door installation.

b. Inshot Type. A conversion burner normally for boiler or furnace ash pit installation and fired in a horizontal position.

c. Upshot Type. A conversion burner normally for boiler or furnace ash pit installation and fired in a vertical position at approximately grate level.

Counter Appliances, Gas. Appliances such as fuel-gas burning coffee brewers and coffee urns and any appurtenant water heating equipment, food and dish warmers, hot plates and griddles.

Cubic Foot (Cu. Ft.) of Gas. The amount of gas which would occupy 1 cubic foot when at a temperature of 60 F, saturated with water vapor and under a pressure equivalent to that of 30.0 inches mercury column.

Decorative Appliance for Installation in a Vented Fireplace. A self-contained, free-standing, fuel-gas burning appliance designed for installation only in a vented fireplace and whose primary function lies in the esthetic effect of the flame.

a. Coal Basket. An open-flame type appliance consisting of a metal basket filled with simulated coals which gives the appearance of a coal fire when in operation.

b. Fireplace Insert. Consists of an open-flame radiant-type appliance mounted in a decorative metal panel to cover the fireplace or mantel opening and having provisions for venting into the fireplace chimney.

c. Gas Log. An open-flame type appliance consisting of a metal frame or base supporting simulated logs.

d. Radiant Appliance. An open-front appliance designed primarily to convert the energy in fuel gas to radiant heat by means of refractory radiants or similar radiating materials. A radiant heater has no external jacket. A radiant appliance is designed for installation in a vented fireplace.

Decorative Appliance, Vented. A vented appliance whose only function lies in the esthetic effect of the flames.

Deep Fat Fryer, Hotel and Restaurant. An appliance including a cooking vessel in which oils or fats are placed to such a depth that the cooking food is essentially supported by displacement of the cooking fluid or a perforated container immersed in the cooking fluid rather than by the bottom of the vessel, designed primarily for use in hotels, restaurants, clubs and similar institutions.

Design Pressure. The maximum operating pressure permitted by this Code, as determined by the design procedures applicable to the materials involved.

Differential Pressure. The pressure difference between two points in a system.

Dilution Air. Air which enters a draft hood or draft regulator and mixes with the flue gases.

Direct-Fired Oven. An oven in which the flue gases flow through the oven compartment.

Direct Gas-Fired Make-Up Air Heater. A heater in which all the products of combustion generated by the fuel-gas burning device are released into the outside air stream being heated.

Direct Vent Appliances. Appliances which are constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged to the outside atmosphere.

Diversity Factor. Ratio of the maximum probable demand to the maximum possible demand.

Draft. The flow of gases or air through chimney, flue or equipment caused by pressure differences.

a. Mechanical or Induced. The draft developed by fan or air or steam jet or other mechanical means.

b. Natural. The draft developed by the difference in temperature of hot gases and outside atmosphere.

Draft Hood. A device built into an appliance, or made a part of the vent connector from an appliance, which is designed to (1) provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood, (2) prevent a backdraft from entering the appliance, and (3) neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance.

Draft Regulator. A device which functions to maintain a desired draft in the appliance by automatically reducing the draft to the desired value.

Drip. The container placed at a low point in a system of piping to collect condensate and from which it may be removed.

Dry Gas. A gas having a moisture and hydrocarbon dew point below any normal temperature to which the gas piping is exposed.

Duct Furnace. A furnace normally installed in distribution ducts of air conditioning systems to supply warm air for heating. This definition applies only to an appliance which depends for air circulation on a blower not furnished as part of the furnace.

Excess Air. Air which passes through the combustion chamber and the appliance flues in excess of that which is theoretically required for complete combustion.

Explosion Heads (Soft Heads or Rupture Discs). A protective device for relieving excessive pressure in a premix system by bursting of a rupturable disc.

Exposed Piping. Gas piping which will be in view in the finished structure.

Fireplace. A fire chamber and hearth constructed of noncombustible material for use with solid fuels and provided with a chimney.

a. Masonry Fireplace. A hearth and fire chamber of solid masonry units such as bricks, stones, listed masonry units, or reinforced concrete, provided with a suitable chimney.

b. Factory-Built Fireplace. A fireplace composed of listed factory-built components assembled in accordance with the terms of listing to form the completed fireplace.

Flame Arrester. A non-valve device for use in a gas-air mixture line containing a means for temporarily stopping the progress of a flame front (flashback).

Flames.

a. Bunsen. The flame produced by premixing some of the air required for combustion with the gas before it reaches the burner ports or point of ignition.

b. Yellow, Luminous or Non-Bunsen. The flame produced by burning gas without any premixing of air with the gas.

Floor Furnace. A completely self-contained unit furnace suspended from the floor of the space being heated, taking air for combustion from outside this space.

a. Fan Type Floor Furnace. A floor furnace equipped with a fan which provides the primary means for circulation of air.

b. Gravity Type Floor Furnace. A floor furnace depending primarily upon circulation of air by gravity. This classification also includes floor furnaces equipped with booster-type fans which do not materially restrict free circulation of air by gravity flow when such fans are not in operation.

Flue, Appliance. The passage(s) within an appliance through which combustion products pass from the combustion chamber of the appliance to the draft hood inlet opening on an appliance equipped with a draft hood or to the outlet of the appliance on an appliance not equipped with a draft hood.

Flue, Chimney. The passage(s) in a chimney for conveying the flue or vent gases to the outside atmosphere.

Flue Collar. That portion of an appliance designed for the attachment of the draft hood or vent connector.

Flue Exhauster. A device installed in and made a part of the vent which will provide a positive induced draft.

Flue Gases. Products of combustion plus excess air in appliance flues or heat exchangers.

Furnace, Central. A self-contained, gas-burning appliance for heating air by transfer of heat of combustion through metal to the air, and designed to supply heated air through ducts to spaces remote from or adjacent to the appliance location.

a. Forced Air Furnace. A furnace equipped with a fan or blower which provides the primary means for circulation of air.

1. Downflow Furnace. A furnace designed with air flow discharge vertically downward at or near the bottom of the furnace.

2. Horizontal Furnace. A furnace designed for low headroom installation with air flow across the heating element essentially in a horizontal path.
3. Upflow Furnace. A furnace designed with air flow discharge vertically upward at or near the top of the furnace. This classification includes "highboy" furnaces with the blower mounted below the heating element and "lowboy" furnaces with the blower mounted beside the heating element.

b. Forced Air Furnace With Cooling Unit. A single-package unit, consisting of a gas-fired forced air furnace of one of the types listed in "a" above combined with an electrically or gas-operated summer air conditioning system, contained in a common casing.

c. Gravity Furnace. A furnace depending primarily on circulation of air by gravity.

d. Gravity Furnace With Booster Fan. A furnace equipped with a booster fan which does not materially restrict free circulation of air by gravity flow when the fan is not in operation.

e. Gravity Furnace With Integral Fan. A furnace equipped with a fan or blower as an integral part of its construction and operable on gravity systems only. The fan or blower is used only to overcome the internal furnace resistance to air flow.

Furnace, Direct Vent Central. A system consisting of (1) a central furnace for indoor installation, (2) combustion air connections between the central furnace and the outdoor atmosphere, (3) flue gas connections between the central furnace and the vent cap, and (4) vent cap for installation outdoors, supplied by the manufacturer and constructed so that all air for combustion is obtained from the outdoor atmosphere and all flue gases are discharged to the outdoor atmosphere.

Furnace, Enclosed. A specific heating, or heating and ventilating, furnace incorporating an integral total enclosure and using only outside air for combustion.

Furnace, Separated Combustion System Central. A system for installation in nonresidential structures consisting of a central furnace and a vent cap supplied by the manufacturer, and (1) combustion air connections between the central furnace and the outside atmosphere and (2) flue gas connections between the central furnace and vent cap (of a type(s) specified by the manufacturer but supplied by the installer), constructed so that when installed in accordance with the manufacturer's instructions, air for combustion is obtained from the outside atmosphere and flue gases are discharged to the outside atmosphere.

Garage, Repair. A building, structure or portions thereof wherein major repair or painting or body and fender work is performed on motorized vehicles or automobiles, and includes associated floor space used for offices, parking and showrooms.

Garage, Residential. A building or room in which not more than three self-propelled passenger vehicles are or may be stored, and which will not normally be used for other than minor service or repair operations on such stored vehicles.

Gas. Fuel gas, such as natural gas, manufactured gas, undiluted liquefied petroleum gas (vapor phase only), liquefied petroleum gas-air mixtures, or mixtures of these gases.

Gas Main or Distribution Main. A pipe installed in a community to convey gas to individual services or other mains.

Gas-Mixing Machine. Any combination of automatic proportioning control devices, blowers or compressors which supply mixtures of gas and air to multiple burner installations where control devices or other accessories are installed between the mixing device and burner.

Gas Utilization Equipment. Any device which utilizes gas as a fuel or raw material or both.

Gas Vent. A passageway, vertical or nearly so, composed of listed factory-built components assembled in accordance with the terms of listing for conveying vent gases from gas appliances or their vent connectors to the outside atmosphere.

a. Type B Gas Vent. A vent for venting listed gas appliances with draft hoods and other gas appliances listed for use with Type B vents.

b. Type B-W Gas Vent. A vent for venting listed gas-fired vented wall furnaces.

Governor, Zero. A regulating device which is normally adjusted to deliver gas at atmospheric pressure within its flow rating.

Gravity. (See Specific Gravity.)

Header. A pipe or fitting to which a number of branch pipes are connected.

Heating Value (Total). The number of British Thermal Units produced by the combustion, at constant pressure, of one cubic foot of gas when the products of combustion are cooled to the initial temperature of the gas and air, when the water vapor formed during combustion is condensed, and when all the necessary corrections have been applied.

Hoop Stress. The stress in a pipe wall, acting circumferentially in a plane perpendicular to the longitudinal axis of the pipe and produced by the pressure of the fluid in the pipe.

Hot Plate, Commercial. (See Counter Appliances, Gas.)

Hot Plate, Domestic. A fuel-gas burning appliance consisting of one or more open-top type burners mounted on short legs or a base.

Hot Taps. Piping connections made to operating pipelines or mains or other facilities while they are in operation. The connection of the branch piping to the operating line and the tapping of the operating line are done while it is under gas pressure.

Hotel and Restaurant Range. A self-contained fuel-gas burning range providing for cooking, roasting, baking or broiling, or any combination of these functions, and not designed specifically for domestic use.

Household Cooking Gas Appliance. A gas appliance for domestic food preparation, providing at least one function of (1) top or surface cooking, (2) oven cooking, or (3) broiling.

a. Broiler. A unit which cooks primarily by radiated heat. Broilers are further classified as:
   1. Enclosed Broiler. A broiler in which the source of radiant heat is above the surface on which cooking is done.
   2. Open Top Broiler. A broiler in which the source of radiant heat is below the surface on which cooking is done.

b. Built-In Unit. A unit designed to be recessed into, placed upon or attached to the construction of a building, but not for installation on the floor. Built-in units are further classified as:
   1. Broiler Unit. May have an open top or be enclosed, may be a separate broiler, or may be combined with a rotisserie.
   2. Oven Unit. A unit for installation in a cabinet, wall or partition, or for installation on a counter. It may be a separate oven, may be equipped with a broiler that uses the oven burner, or the oven may serve as a broiler with a burner in the upper portion of the oven.
   3. Top or Surface Unit. A unit for installation in or on a counter top. It may have top burners, a griddle, a deep well cooker or any combination thereof.
   4. Combination of "1," "2" or "3" above, or any other household cooking device that may be for similar installation.

c. Floor Mounted Unit. A self-contained cooking appliance for installation directly on the floor. It has a top section and an oven section. It may have additional sections. Included in this classification are:
   1. Bungalow (Utility Type). A cooking appliance having a gas oven and top section, and a gas, solid or liquid fuel section for

space heating and heating a solid top section but not for oven heating.

2. Room Heater Type. A cooking appliance having a gas oven and top section, and a separate room heater section designed for gas fuel.

Incinerator, Domestic. A domestic, fuel-gas burning appliance, used to reduce refuse material to ashes, which is manufactured, sold and installed as a complete unit.

Indirect Oven. An indirect oven is one in which the flue gases do not flow through the oven compartment.

Infrared Heater. A heater which directs a substantial amount of its energy output in the form of infrared energy into the area to be heated. Such heaters may be of either the vented or unvented type.

Insulating Millboard. A factory fabricated board formed with noncombustible materials, normally fibers, and having a thermal conductivity in the range of 1 Btu inch per square foot per °F per hour.

Joint. A connection between two lengths of pipe or between a length of pipe and a fitting.

a. Adhesive. A joint made in plastic piping by the use of an adhesive substance which forms a continuous bond between the mating surfaces without dissolving either one of them.

b. Heat Fusion. A joint made in thermoplastic piping by heating the parts sufficiently to permit fusion of the materials when the parts are pressed together.

c. Solvent Cement. A joint made in thermoplastic piping by the use of a solvent or solvent cement which forms a continuous bond between the mating surfaces.

Joint Compounds. Nonhardening materials used on pipe threads to insure a seal.

Kettle, Gas-Fired. An appliance with a cooking chamber which is heated either by a steam jacket in which steam is generated by gas heat or by direct gas heat applied to the cooking chamber.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Laundry Stove, Domestic. A fuel-gas burning appliance consisting of one or more open-top type burners mounted on high legs or having a cabinet base.

Leak Detector. An instrument for determining concentration of gas in air.

Leakage Surveys. Systematic surveys made for the purpose of locating leaks in a gas piping system.

Limit Control. A device responsive to changes in pressure, temperature or liquid level for turning on, shutting off, or throttling the gas supply to an appliance.

Listed. Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

Loads, Connected. Sum of the rated Btu input to individual gas utilization equipment connected to a piping system. May also be expressed in cubic feet per hour.

Main Burner. A device or group of devices essentially forming an integral unit for the final conveyance of gas or a mixture of gas and air to the combustion zone, and on which combustion takes place to accomplish the function for which the appliance is designed.

Manifold, Gas. The conduit of an appliance which supplies gas to the individual burners.

Maximum Allowable Hoop Stress. The maximum hoop stress permitted by this Code for the design of a piping system.

Maximum Working Pressure. The maximum pressure at which a piping system may be operated in accordance with the provisions of this Code. It is the pressure used in determining the setting of pressure relieving or pressure limiting devices installed to protect the system from accidental over-pressuring.

Measured Gas. Gas which has passed through and the volume of which has been measured by a meter, or gas which has been otherwise measured such as by liquid volume or weight.

Mechanical Exhaust System. Equipment installed in and made a part of the vent, which will provide a positive induced draft.

Meter. An instrument installed to measure the volume of gas delivered through it.

Mixer. The combination of mixer head, mixer throat and mixer tube.

a. Mixer Head. The portion of an injection (Bunsen) type burner, usually enlarged, into which primary air flows to mix with the gas stream.

b. Mixer Throat. The portion of the mixer which has the smallest cross-sectional area and which lies between the mixer head and the mixer tube.

c. Mixer Tube. The portion of the mixer which lies between the throat and the burner head.

Mixer Face. The air inlet end of the mixer head.

Mixing Blower. A motor-driven blower to produce gas-air mixtures for combustion through one or more gas burners or nozzles on a single-zone industrial heating appliance or on each control zone of a multi-zone industrial appliance or on each control zone of a multi-zone installation. The blower shall be equipped with a gas-control valve at its air entrance so arranged that gas is admitted to the airstream, entering the blower in proper proportions for correct combustion by the type of burners employed; the said gas-control valve being of either the zero governor or mechanical ratio valve type which controls the gas and air adjustment simultaneously. No valves or other obstructions shall be installed between the blower discharge and the burner or burners.

Noncombustible Material. For the purpose of this Code, noncombustible material shall mean material which is not capable of being ignited and burned, such as materials consisting entirely of, or a combination of, steel, iron, brick, tile, concrete, slate, asbestos, glass and plaster.

Operating Stress. The stress in a pipe or structural member under normal operating conditions.

Orifice. The opening in a cap, spud or other device whereby the flow of gas is limited and through which the gas is discharged to the burner.

Orifice Cap (Hood). A movable fitting having an orifice which permits adjustment of the flow of gas by the changing of its position with respect to a fixed needle or other device.

Orifice Spud. A removable plug or cap containing an orifice which permits adjustment of the flow of gas either by substitution of a spud with a different sized orifice or by the motion of a needle with respect to it.

Outdoor Cooking Gas Appliance. As used in this Code, a post-mounted, fuel-gas burning outdoor cooking appliance for installation directly on and attachment to a post provided as a part of the appliance by the manufacturer.

Oven, Commercial Gas Baking and Roasting. An oven primarily intended for volume food preparation which may be composed of one or more sections or units of the following types:

a. Cabinet Oven. An oven having one or more cavities heated by a single burner or group of burners.

b. Reel-Type Oven. An oven employing trays that are moved by mechanical means.

c. Sectional Oven. An oven composed of one or more independently heated cavities.

Parking Structure. A building, structure or portion thereof used for the parking of motor vehicles.

a. Basement or Underground. A parking structure or portion thereof located below grade.

b. Enclosed. Having exterior enclosing walls which have less than 25 percent of the total wall area open to atmosphere at each level using at least two sides of the structure.

Pilot. A small flame which is utilized to ignite the gas at the main burner or burners.

Pipe, Equivalent Length. The resistance of valves, controls and fittings to gas flow expressed as equivalent length of straight pipe for convenience in calculating pipe sizes.

Piping. As used in this Code, either pipe or tubing, or both.

a. Pipe. Rigid conduit of iron, steel, copper, brass, aluminum or plastic.

b. Tubing. Semi-rigid conduit of copper, steel, aluminum or plastic.

Piping System. All piping, valves and fittings used to connect gas utilization equipment to the point of delivery.

Plastic.

a. Thermoplastic. A plastic which is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

b. Thermosetting. A plastic which is capable of being changed into a substantially infusible or insoluble product when cured under application of heat or chemical means.

Pool Heater. An appliance designed for heating nonpotable water stored at atmospheric pressure, such as water in swimming pools, therapeutic pools, and similar applications.

a. Coil Type Pool Heater. A type of pool heater whose heat exchanger surfaces are composed primarily of water tubes whose inside diameters are less than 1¼ inches.

b. Indirect Type Pool Heater. A type of pool heater that utilizes water in a primary heat exchanger to transmit heat from the gas combustion process by means of a secondary heat exchanger to the pool water.

Pressure. Unless otherwise stated, is expressed in pounds per square inch above atmospheric pressure, i.e., gage pressure (psig).

Pressure Control. Manual or automatic maintenance of pressure, in all or part of a system, at a predetermined level, or within a selected range.

Pressure Drop. The loss in static pressure of the medium (air, gas or water) due to friction or obstruction in pipe, valves, fittings, regulators and burners.

Pressure Limiting Device. Equipment which under abnormal conditions will act to reduce, restrict or shut off the supply of gas flowing into a system in order to prevent the gas pressure in that system from exceeding a predetermined value.

Pressure or Vacuum Limit Switch. A device in a control system actuated by pressure or vacuum within the air or gas piping system.

Primary Air. The air introduced into a burner which mixes with the gas before it reaches the port or ports.

Protective Equipment. Safety devices designed to forestall the development of a hazardous or undesirable condition in the fuel supply piping, in the gas equipment, in the medium being treated, or in the combustion products.

Purge. To free a gas conduit of air, or gas, or a mixture of gas and air.

Quick-Disconnect Device. A hand-operated device which provides a means for connecting and disconnecting an appliance or an appliance connector to a gas supply and which is equipped with an automatic means to shut off the gas supply when the device is disconnected.

Readily Accessible. Having direct access without the need of removing or moving any panel, door or similar covering of the item described.

Refrigerator (Using Gas Fuel). A fuel-gas burning appliance which is designed to extract heat from a suitable chamber.

Regulator, Gas Appliance. A pressure regulator for controlling pressure to the manifold of gas equipment. Types of gas appliance regulators are as follows:

a. Adjustable.
   1. Spring Type, Limited Adjustment. A regulator in which the regulating force acting upon the diaphragm is derived prin-

cipally from a spring, the loading of which is adjustable over a range of not more than ± 15 percent of the outlet pressure at the midpoint of the adjustment range.

2. Spring Type, Standard Adjustment. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is adjustable. The adjustment means shall be concealed.

b. Convertible. A nonadjustable regulator for conversion between gases having different heating values whose converting mechanism can be changed from one predetermined outlet pressure setting for one gas to another predetermined outlet pressure setting for the other gas with no intermediate pressure settings and without addition, deletion or substitution of parts.

c. Multistage. A regulator for use with a single gas whose adjustment means can be positioned manually or automatically to two or more predetermined outlet pressure settings. Each of these settings may be either adjustable or nonadjustable. The regulator may modulate outlet pressures automatically between its maximum and minimum predetermined outlet pressure settings.

d. Nonadjustable.

1. Spring Type, Nonadjustable. A regulator in which the regulating force acting upon the diaphragm is derived principally from a spring, the loading of which is not field adjustable.
2. Weight Type. A regulator in which the regulating force acting upon the diaphragm is derived from a weight or combination of weights.

Regulator, Line Gas. A pressure regulator placed in a gas line between the service regulator and the gas appliance regulator.

Regulator, LP-Gas, First Stage. On undiluted LP-gas systems, the first pressure regulator reducing the storage container pressure.

Regulator, LP-Gas, Second Stage. A line gas pressure regulator for service on undiluted LP-gas systems, reducing an intermediate high pressure to utilization pressure.

Regulator, Monitoring. A pressure regulator set in series with another pressure regulator for the purpose of automatically taking over in an emergency the control of the pressure downstream of the regulator in case that pressure tends to exceed a set maximum.

Regulator, Pressure. A device placed in a gas line for reducing, controlling and maintaining the pressure in that portion of the piping system downstream of the device.

Regulator, Series. A pressure regulator in series with one or more other pressure regulators. The regulator nearest to the gas supply source is set to continuously limit the pressure on the inlet to the regulator downstream to some predetermined value (between the pressure of the gas supply source and the pressure of the system being controlled) which can be tolerated in the downstream system.

Regulator, Service. A pressure regulator installed by the serving gas supplier to reduce and limit the service line gas pressure to delivery pressure.

Regulator Vent. The opening in the atmospheric side of the regulator housing permitting the in and out movement of air to compensate for the movement of the regulator diaphragm.

Relief Opening. The opening provided in a draft hood to permit the ready escape to the atmosphere of the flue products from the draft hood in the event of no draft, backdraft or stoppage beyond the draft hood, and to permit inspiration of air into the draft hood in the event of a strong chimney updraft.

Room Heater, Unvented. An unvented, self-contained, free-standing, nonrecessed (except as noted under "b" of the following classifications), fuel-gas burning appliance for furnishing warm air by gravity or fan circulation to the space in which installed, directly from the heater without duct connection. Unvented room heaters do not normally have input ratings in excess of 40,000 Btu per hour.

a. Unvented Circulator. A room heater designed to convert the energy in fuel gas to convected and radiant heat by direct mixing of air to be heated with the combustion products and excess air inside the jacket. Unvented circulators have an external jacket surrounding the burner and may be equipped with radiants with the jacket open in front of the radiants.

b. Wall Heater, Unvented Closed Front. An unvented circulator having a closed front, for insertion in or attachment to a wall or partition. These heaters are marked, "UNVENTED HEATER," and do not have normal input ratings in excess of 25,000 Btu per hour.

Room Heater, Vented. A vented, self-contained, free-standing, nonrecessed, fuel-gas burning appliance for furnishing warm air to the space in which installed, directly from the heater without duct connections.

a. Vented Circulator. A room heater designed to convert the energy in fuel gas to convected and radiant heat, by transfer of heat from flue gases to a heat exchanger surface, without mixing of flue gases with circulating heated air. Vented circulators may be equipped with transparent panels and radiating surfaces to increase radiant heat transfer as long as separation of flue gases from circulating air is maintained. Vented circulators may also be equipped with an optional circulating air fan, but should perform satisfactorily with or without the fan in operation.

b. Vented Circulator, Fan Type. A vented circulator equipped with an integral circulating air fan, the operation of which is necessary for satisfactory appliance performance.

c. Vented Overhead Heater. A room heater designed for suspension from or attachment to or adjacent to the ceiling of the room being heated and transferring the energy of the fuel gas to the space being heated primarily by radiation downward from a hot surface, and in which there is no mixing of flue gases with the air of the space being heated.

Room Large in Comparison with Size of Equipment. Rooms having a volume equal to at least 12 times the total volume of a furnace or air conditioning appliance and at least 16 times the total volume of a boiler. Total volume of the appliance is determined from exterior dimensions and is to include fan compartments and burner vestibules, when used. When the actual ceiling height of a room is greater than 8 feet, the volume of the room is figured on the basis of a ceiling height of 8 feet.

Safety Blowout (Backfire Preventer). A protective device located in the discharge piping of large mixing machines, incorporating a bursting disc for excessive pressure release, means for stopping a flame front and an electric switch or other release mechanism for actuating a built-in or separate safety shutoff. A check valve, signaling means, or both, may also be incorporated.

Safety Shutoff Device. A device that will shut off the gas supply to the controlled burner(s) in the event the source of ignition fails. This device may interrupt the flow of gas to main burner(s) only, or to pilot(s) and main burner(s) under its supervision.

Sauna Heater. A vented heater designed to raise the temperature of an occupied room to a temperature in excess of 100 F. The appliance may or may not include the means for altering the humidity within the room.

a. Direct Vent Sauna Heater. A system consisting of an appliance, combustion air and flue gas connections between the appliance and the outside atmosphere and a vent cap supplied by the manufacturer and constructed so that all air for combustion is obtained from the outside atmosphere. The appliance should be complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building, and should furnish heated air circulated directly into the space to be heated through openings in the casing. Such appliances should not be provided with duct extensions.

b. Flue-Connected Sauna Heater. An appliance designed for connection to a chimney or gas vent. All air for combustion and draft hood dilution is obtained from a room effectively sealed from the heated room but not from outside the structure containing the heated room.

Secondary Air. The air externally supplied to the flame at the point of combustion.

Secondary Stress. Stress created in the pipe wall by loads other than internal fluid pressure. For example, backfill loads, traffic loads, beam action in a span, loads at supports and at connections to the pipe.

Service Meter Set Assembly. The piping and fittings installed by the serving gas supplier to connect the inlet side of the meter to the gas service and to connect the outlet side of the meter to the customer's house or yard piping.

Service Pipe. The pipe which brings the gas from the gas main to the meter.

Service Regulator. (See Regulator, Service Pressure.)

Shall. Indicates a mandatory requirement.

Shutoff. (See Valve.)

Space, Confined. For the purposes of this Code, a space whose volume is less than 50 cubic feet per 1,000 Btu per hour of the aggregate input rating of all appliances installed in that space.

Space, Unconfined. For purposes of this Code, a space whose volume is not less than 50 cubic feet per 1,000 Btu per hour of the aggregate input rating of all appliances installed in that space. Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

Specific Gravity. As applied to gas, the ratio of the weight of a given volume to that of the same volume of air, both measured under the same conditions.

Steam Cooker. A fuel-gas burning appliance which cooks, defrosts or reconstitutes food by direct contact with steam.

Steam Generator. A separate appliance primarily intended to supply steam for use with commercial cooking equipment.

Stress. The resultant internal force that resists change in the size or shape of a body acted on by external forces. In this Code "stress" is often used as being synonymous with unit stress which is the stress per unit area (psi).

Tensile Strength. The highest unit tensile stress (referred to the original cross section) a material can sustain before failure (psi).

Thermostat, Electric Switch Type. A device which senses changes in temperature and controls electrically, by means of separate components, the flow of gas to the burners to maintain selected temperatures.

Thermostat, Integral Gas Valve Type. An automatic device, actuated by temperature changes, designed to control the gas supply to the burners in order to maintain temperatures between predetermined limits, and in which the thermal actuating element is an integral part of the device.

a. Graduating Thermostat. A thermostat in which the motion of the valve is approximately in direct proportion to the effective motion of the thermal element induced by temperature change.

b. Snap-Acting Thermostat. A thermostat in which the thermostatic valve travels instantly from the closed to the open position, and vice versa.

Type B Gas Vent. (See Gas Vents.)

Type B-W Gas Vent. (See Gas Vents.)

Type L Vent. A passageway, vertical or nearly so, composed of listed factory-built components assembled in accordance with the terms of listing for conveying vent gases from listed appliances for use with Type L vents or their vent connectors to the outside atmosphere.

Unit Broiler. A broiler constructed as a separate appliance.

Unit Heater.

a. High-Static Pressure. A self-contained, automatically controlled, vented, fuel-gas burning appliance having integral means for circulation of air against 0.2 inch or greater static pressure. It is equipped with provisions for attaching an outlet air duct and, when the appliance is for indoor installation remote from the space to be heated, is also equipped with provisions for attaching an inlet air duct.

b. Low-Static Pressure. A self-contained, automatically controlled, vented, fuel-gas burning appliance, intended for installation in the space to be heated without the use of ducts, having integral means for circulation of air, normally by a propeller fan(s), and may be equipped with louvers or face extensions made in accordance with the manufacturer's specifications.

Unmeasured Gas. Gas which has not passed through and the volume of which has not been measured by a meter, or gas which has not otherwise been measured such as by liquid volume or weight.

Utility Gases. Natural gas, manufactured gas, liquefied petroleum gas-air mixtures, or mixtures of any of these gases.

Valve. A device used in piping to control the gas supply to any section of a system of piping or to an appliance.

Valve, Automatic. An automatic or semi-automatic device consisting essentially of a valve and operator that controls the gas supply to the burner(s) during operation of an appliance. The operator may be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other means.

Valve, Automatic Gas Shutoff. A valve used in conjunction with an automatic gas shutoff device to shut off the gas supply to a fuel-gas burning water heating system. It may be constructed integrally with the gas shutoff device, or be a separate assembly.

Valve, Individual Main Burner. A valve which controls the gas supply to an individual main burner.

Valve, Main Burner Control. A valve which controls the gas supply to the main burner manifold.

Valve, Manual Main Gas-Control. A manually operated valve in the gas line for the purpose of completely turning on or shutting off the gas supply to the appliance except to pilot or pilots which are provided with independent shutoff.

Valve, Manual Reset. An automatic shutoff valve installed in the gas supply piping and set to shut off when unsafe conditions occur. The device remains closed until manually reopened.

Valve, Relief. A safety valve designed to forestall the development of a dangerous condition by relieving either pressure, temperature or vacuum in a hot water supply system.

a. Pressure. A valve which automatically opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value.

b. Temperature. A valve which automatically opens and automatically closes a relief vent, depending on whether the temperature is above or below a predetermined value.

c. Vacuum. A valve which automatically opens and closes a vent for relieving a vacuum within the hot water supply system depending on whether the vacuum is above or below a predetermined value.

Valve, Service Shutoff. A valve, installed by the serving gas supplier between the service meter or source of supply and the customer piping system, to shut off the entire piping system.

Valve, Shutoff. A valve (located in the piping system and readily accessible and operable by the consumer) used to shut off individual equipment.

Valve, Tamperproof. Valves designed and constructed to minimize the possibility of the removal of the core of the valve accidentally or willfully with ordinary household tools.

Vent. A passageway, vertical or nearly so, used to convey flue gases from gas utilization equipment, or their vent connectors, to the outside atmosphere.

Vent Connector. The pipe or duct which connects a fuel-gas burning appliance to a vent or chimney.

NOTE: Since a vent is a vertical or nearly vertical passageway, it follows that any pipe or duct used to connect an appliance(s) to such vertical vent is a vent connector. However if the vertical vent is connected directly to an appliance draft hood or flue collar, a vent connector is not involved.

Vent Damper Device, Automatic. A device intended for installation in the venting system, in the outlet of or downstream of the appliance draft hood, of an individual automatically operated fuel-gas burning appliance and which is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in a standby or shutdown condition.

a. Electrically Operated. An automatic vent damper device that employs electrical energy to control the device.

b. Mechanically Actuated. An automatic vent damper device dependent for operation upon the direct application or transmission of mechanical energy without employing any type of energy conversion.

c. Thermally Actuated. An automatic vent damper device dependent for operation exclusively upon the direct conversion of the thermal energy of the vent gases into mechanical energy.

Vent Gases. Products of combustion from fuel-gas burning appliances plus excess air, plus dilution air in the venting system above the draft hood or draft regulator.

Vented Wall Furnace. A self-contained, vented, fuel-gas burning appliance complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building and furnishing heated air, circulated by gravity or by a fan, directly into the space to be heated through openings in the casing. Such appliances should not be provided with duct extensions beyond the vertical and horizontal limits of the casing proper, except that boots not to exceed 10 inches beyond the horizontal limits of the casing for extension through walls of nominal thickness are permitted. When such boots are provided they shall be supplied by the manufacturer as an integral part of the appliance. This definition excludes floor furnaces, unit heaters, direct vent wall furnaces and central furnaces.

a. Fan Type Vented Wall Furnace. A wall furnace equipped with a fan.

b. Gravity Type Vented Wall Furnace. A wall furnace depending on circulation of air by gravity.

Venting. Removal of combustion products as well as noxious or toxic process fumes to the outer air by means of roof openings, natural draft chimneys or mechanical exhaust systems.

Venting System. A continuous open passageway from the flue collar or draft hood of a gas-burning appliance to the outside atmosphere for the purpose of removing flue or vent gases.

NOTE: A venting system is usually composed of a vent or a chimney and vent connector(s), if used, assembled to form the open passageway.

Wall Furnace, Direct Vent. A system consisting of an appliance, combustion air and flue gas connections between the appliance and the outdoor atmosphere, and a vent cap supplied by the manufacturer and constructed so that all air for combustion is obtained from the outdoor atmosphere and all flue gases are discharged to the outdoor atmosphere. The appliance shall be complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building, mobile home or recreational vehicle and shall furnish heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing. Such appliances shall not be provided with duct extensions beyond the vertical and horizontal limits of the appliance casing, except that boots not to exceed 10 inches beyond the horizontal limits of the casing for extension through walls or nominal thickness may be permitted. This definition excludes floor furnaces, unit heaters, vented wall furnaces and central furnaces as defined in appropriate American National Standards.

Water Heater. An appliance for supplying hot water for domestic or commercial purposes other than for space heating.

a. Automatic Instantaneous Water Heater. A water heater which has a rated input of at least 4,000 Btu per hour per gallon of self-stored water. Automatic control is obtained by water-actuated control, thermostatic control, or combination of water-actuated control and thermostatic control. This classification includes faucet type water heaters designed to deliver water through a single faucet integral with or directly adjacent to the appliance.

b. Circulating Heaters.
   1. Automatic Circulating Tank Water Heater. A water heater which furnishes hot water to be stored in a separate vessel. Storage tank temperatures are controlled by means of a thermostat installed on the water heater. Circulation may be either gravity or forced.
   2. Nonautomatic Circulating Tank Water Heater. A water heater which furnishes hot water to be stored in a separate vessel. Storage tank temperatures are controlled by means of a thermostat installed in the storage vessel.

c. Coil Circulation Water Heater. A water heater whose heat transfer surface is composed primarily of water tubes less than 1½ inches in internal diameter and which requires circulation.

d. Commercial Storage Heater. A water heater that heats and stores water at a thermostatically controlled temperature for delivery on demand. Input rating: 75,000 Btu per hour or more.

e. Counter Top Domestic Storage Heater.
   1. Concealed Type. A vented automatic storage heater which is designed for flush installation beneath a counter top 36 inches high, wherein the entire heater is concealed.
   2. Flush Type. A vented automatic storage water heater with flat sides, top, front and back, which is designed primarily for flush installation in conjunction with or adjacent to a counter 36 inches high, wherein the front and top of the heater casing are exposed.
   3. Recessed Type. A vented automatic storage water heater with flat sides, top, front and back, which is designed for flush installation beneath a counter 36 inches high, wherein the front of the heater casing is exposed.

f. Domestic Storage Heater. A water heater that heats and stores water at a thermostatically controlled temperature for delivery on demand. Input rating may not exceed 75,000 Btu per hour.

g. Side-Arm Type Water Heater. A water heater designed for use with auxiliary storage systems, usually containing water-carrying parts of the tubular or cast element design.

Water Heater, Direct Vent. A system consisting of (1) a water heater for indoor installation, (2) combustion air connections between the water heater and the outside atmosphere, (3) flue gas connections between the water heater and the vent cap, and (4) a vent cap for installation outdoors, supplied by the manufacturer and constructed so all air for combustion is obtained from the outside atmosphere and all flue gases are discharged to the outside atmosphere.

APPENDIX A

LIST OF REFERENCE STANDARDS

(Sources for reference standards, given in A5 of this Appendix, are denoted by superscript numbers.)

A1. Standards for Equipment and Installations Not Within the Scope of This Code

ANSI/ASME Boiler and Pressure Vessel Code, 1983 Edition, Section III ("Nuclear Power Plant Components"), Division 1-Subsections NB, NC and ND, Article 3600.

ANSI/ASME Code for Pressure Piping[1]
- B31.1-1983, Power Piping
- B31.3-1984, Chemical Plant and Petroleum Refinery Piping
- B31.4-1979, Liquid Petroleum Transportation Piping Systems
- B31.5-1983, Refrigeration Piping
- B31.8-1982, Gas Transmission and Distribution Piping Systems

ANSI/NFPA 51-1983, Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes[2]

ANSI/NFPA 59-1979, Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants[2]

ANSI/NFPA 59A-1979, Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG)[2]

ANSI/NFPA 61B-1980, Standard for the Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities[2]

A2. Reference Standards Which May Be Used in Applying This Code

ANSI A119.2-1982, Standard for Recreational Vehicles[3]

ANSI A119.4-1982, Standard for Recreational Vehicle Parks and Campgrounds[3]

ANSI A225.1-1984, Standard for Manufactured Home Installations 1982 (Manufactured Home Sites, Communities and Setups)[3]

ANSI Z21.8-1984, Standard for Installation of Domestic Gas Conversion Burners[4]

ANSI Z83.3-1971, and Addenda, Z83.3a-1972 and Z83.3b-1976, Standard for Gas Utilization Equipment in Large Boilers[4]

ANSI/ASTM D2385-81, Method of Test for Hydrogen Sulfide and Mercaptan Sulfur in Natural Gas (Cadmium Sulfate—Iodometric Titration Method)[5]
ANSI/ASTM D2420-81, Method of Test for Hydrogen Sulfide in Liquefied Petroleum (LP) Gases (Lead Acetate Method)[5]
ANSI/NFPA 30-1981, Flammable and Combustible Liquids Code[2]
ANSI/NFPA 37-1979, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines[2]
ANSI/NFPA 58-1983, Standard for the Storage and Handling of Liquefied Petroleum Gases[2]
ANSI/NFPA 68-1978, Guide for Explosion Venting[2]
ANSI/NFPA 70-1984, National Electrical Code[2]
ANSI/NFPA 82-1982, Standard on Incinerators, Waste and Linen Handling Systems and Equipment[2]
ANSI/NFPA 85A-1982, Standard for the Prevention of Furnace Explosions in Fuel Oil- and Natural Gas-Fired Single Burner Boiler-Furnaces[2]
ANSI/NFPA 85B-1978, Standard for the Prevention of Furnace Explosions in Natural Gas-Fired Multiple Burner Boiler-Furnaces[2]
ANSI/NFPA 86A-1977, Standard for Ovens and Furnaces—Design, Location and Equipment[2]
ANSI/NFPA 86B-1982, Standard for Industrial Furnaces—Design, Location and Equipment[2]
ANSI/NFPA 90A-1981, Standard for the Installation of Air Conditioning and Ventilating Systems[2]
ANSI/NFPA 90B-1980, Standard for the Installation of Warm Air Heating and Air Conditioning Systems[2]
ANSI/NFPA 96-1980, Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment[2]
ANSI/NFPA 211-1980, Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances[2]
ANSI/NFPA 409-1979, Standard on Aircraft Hangars[2]
API Std. 1104-1983, Standard for Welding Pipelines and Related Facilities (16th edition)[6]
ASHRAE Handbook and Product Directory, Equipment Volume, 1983[7]
Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280[8]
National Building Code, 1976[9]
NFPA 88A-1979, Standard for Parking Structures[10]
NFPA 88B-1979, Standard for Repair Garages[10]

A3. Reference Standards for Material Specifications

Steel Pipe and Tubing

ANSI A21.52-1982, Standard for Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Gas[3]

ANSI B36.10-1979, Standard for Welded and Seamless Wrought-Steel Pipe[3]

ANSI/ASTM A254-79, Standard Specification for Copper Brazed Steel Tubing[5]

ANSI/ASTM A539-79, Standard Specification for Electric Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines[5]

ASTM A53-83, Specification for Black and Hot-Dipped, Zinc Coated Welded and Seamless Steel Pipe[11]

ASTM A106-83, Specification for Seamless Carbon Steel Pipe for High-Temperature Service[11]

ASTM A120-83, Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses[11]

ASTM A377-79, Specification for Gray Iron and Ductile Iron Pressure Pipe[11]

Copper and Brass Pipe and Tubing (For all standards.)[11]

ASTM B88-83, Specification for Seamless Copper Water Tube

ASTM B280-83, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

Aluminum Pipe and Tubing (For all standards.)[11]

ASTM B210-82a, Specification for Aluminum-Alloy Drawn Seamless Tubes

ASTM B241-83a, Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

Plastic Pipe, Tubing and Fittings (For all standards.)[11]

ASTM D2513-82, Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings

ASTM D2517-81, Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings

Flanges

ANSI B16.1-1975, Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800[3]

ANSI B16.5-1981, Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys[3]

ANSI B16.20-1973, Standard for Ring-Joint Gaskets and Grooves for Steel Pipe Flanges[3]

ANSI/AWWA C111/A21.11-1980, Standard for Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings[12]

MSS SP-6-1980, Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings[13]

Miscellaneous

ANSI/ASME B1.20.1-1983, Standard for Pipe Threads, General Purpose (Inch)[1]

ANSI/ASME Boiler and Pressure Vessel Code (1983 Edition)[1]

ANSI/MSS SP-58-1983, Standard Practice for Pipe Hangers and Supports—Materials, Design and Manufacture[14]

A4. Reference Standards for Equipment and Accessories

Equipment (For all standards.)[4]

ANSI Z21.1-1982, and Addenda, Z21.1a-1982, Household Cooking Gas Appliances

ANSI Z21.5.1-1982, Gas Clothes Dryers, Volume I, Type 1 Clothes Dryers

ANSI Z21.5.2-1979, and Addenda, Z21.5.2a-1981 and Z21.5.2b-1982, Gas Clothes Dryers, Volume II, Type 2 Clothes Dryers

ANSI Z21.10.1-1981, and Addenda, Z21.10.1a-1982 and Z21.10.1b-1983, Gas Water Heaters, Volume I, Automatic Storage Water Heaters With Inputs of 75,000 Btu Per Hour or Less

ANSI Z21.10.3-1981, and Addenda, Z21.10.3a-1982 and Z21.10.3b-1983, Gas Water Heaters, Volume III, Circulating Tank, Instantaneous and Large Automatic Storage Water Heaters

ANSI Z21.11.1-1983, Gas-Fired Room Heaters, Volume I, Vented Room Heaters

ANSI Z21.11.2-1983, Gas-Fired Room Heaters, Volume II, Unvented Room Heaters

ANSI Z21.13-1982, and Addenda, Z21.13a-1983, Gas-Fired Low-Pressure Steam and Hot Water Boilers

ANSI Z21.19-1983, Refrigerators Using Gas Fuel

ANSI Z21.40.1-1981, and Addenda, Z21.40.1a-1982, Gas-Fired Absorption Summer Air Conditioning Appliances

ANSI Z21.42-1971, and Addenda, Z21.42a-1973 and Z21.42b-1981, Gas-Fired Illuminating Appliances

ANSI Z21.44-1981, and Addenda, Z21.44a-1982 and Z21.44b-1982, Gas-Fired Gravity and Fan Type Direct Vent Wall Furnaces

ANSI Z21.47-1983, Gas-Fired Central Furnaces (Except Direct Vent and Separated Combustion System Central Furnaces)
ANSI Z21.48-1982, and Addenda, Z21.48a-1982, Gas-Fired Gravity and Fan Type Floor Furnaces
ANSI Z21.49-1982, and Addenda, Z21.49a-1982, Gas-Fired Gravity and Fan Type Vented Wall Furnaces
ANSI Z21.50-1982, and Addenda, Z21.50a-1982, Vented Decorative Gas Appliances
ANSI Z21.56-1983, and Addenda, Z21.56a-1984, Gas-Fired Pool Heaters
ANSI Z21.57-1982, and Addenda, Z21.57a-1982, Recreational Vehicle Cooking Gas Appliances
ANSI Z21.58-1982, and Addenda, Z21.58a-1982, Outdoor Cooking Gas Appliances
ANSI Z21.60-1981, and Addenda, Z21.60a-1982, Decorative Gas Appliances for Installation in Vented Fireplaces
ANSI Z21.61-1983, Gas-Fired Toilets
ANSI Z21.64-1978, and Addenda, Z21.64a-1980 and Z21.64b-1982, Direct Vent Central Furnaces
ANSI Z83.4-1980 and Addenda, Z83.4a-1982 and Z83.4b-1983, Direct Gas-Fired Make-Up Air Heaters
ANSI Z83.6-1982, Gas-Fired Infrared Heaters
ANSI Z83.8-1981, and Addenda, Z83.8a-1982 and Z83.8b-1983, Gas Unit Heaters
ANSI Z83.9-1982, and Addenda, Z83.9a-1983, Gas-Fired Duct Furnaces
ANSI Z83.10-1982, and Addenda, Z83.10a-1983, Separated Combustion System Central Furnaces
ANSI Z83.11-1980, and Addenda, Z83.11a-1983, Gas Food Service Equipment - Ranges and Unit Broilers
ANSI Z83.12-1980, and Addenda, Z83.12a-1983, Gas Food Service Equipment - Baking and Roasting Ovens
ANSI Z83.13-1980, and Addenda, Z83.13a-1983, Gas Food Service Equipment - Deep Fat Fryers
ANSI Z83.14-1980, and Addenda, Z83.14a-1983, Gas Food Service Equipment - Counter Appliances
ANSI Z83.15-1980, and Addenda, Z83.15a-1983, Gas Food Service Equipment - Kettles, Steam Cookers and Steam Generators
ANSI Z83.16-1982, Unvented Commercial and Industrial Heaters

Accessories (For all standards.)[4]
ANSI Z21.2-1983, Gas Hose Connectors for Portable Indoor Gas-Fired Equipment

ANSI Z21.12-1981, and Addenda, Z21.12a-1983, Draft Hoods

ANSI Z21.15-1979, and Addenda, Z21.15a-1981, Manually Operated Gas Valves

ANSI Z21.17-1984, Domestic Gas Conversion Burners

ANSI Z21.18-1981, and Addenda, Z21.18a-1982, Gas Appliance Pressure Regulators

ANSI Z21.20-1979, and Addenda, Z21.20a-1979 and Z21.20b-1982, Automatic Gas Ignition Systems and Components

ANSI Z21.21-1974, and Addenda, Z21.21a-1977 and Z21.21b-1981, Automatic Valves for Gas Appliances

ANSI Z21.22-1979, and Addenda, Z21.22a-1983, Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

ANSI Z21.23-1980, Gas Appliance Thermostats

ANSI Z21.24-1981, and Addenda, Z21.24a-1983, Metal Connectors for Gas Appliances

ANSI Z21.35-1969, Gas Filters on Appliances

ANSI Z21.41-1978, and Addenda, Z21.41a-1981 and Z21.41b-1983, Quick-Disconnect Devices for Use With Gas Fuel

ANSI Z21.45-1979, and Addenda, Z21.45a-1981 and Z21.45b-1983, Flexible Connectors of Other Than All-Metal Construction for Gas Appliances

ANSI Z21.54-1979, and Addenda, Z21.54a-1983, Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances

ANSI Z21.66-1977, and Addenda, Z21.66a-1981 and Z21.66b-1982, Electrically Operated Automatic Vent Damper Devices for Use With Gas-Fired Appliances

ANSI Z21.67-1978, and Addenda, Z21.67a-1981 and Z21.67b-1982, Mechanically Actuated Automatic Vent Damper Devices for Use With Gas-Fired Appliances

ANSI Z21.68-1978, and Addenda, Z21.68a-1981 and Z21.68b-1982, Thermally Actuated Automatic Vent Damper Devices for Use With Gas-Fired Appliances

ANSI Z21.69-1979, and Addenda, Z21.69a-1983, Connectors for Movable Gas Appliances

ANSI/UL 144-1977, Pressure Regulating Valves for LP-Gas[15]

A5. Sources for Reference Standards

1. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.

2. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.
3. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.
4. American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209, or the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.
5. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.
6. American Petroleum Institute, 2101 L Street, N.W., Washington, D.C. 20037
7. American Society of Heating, Refrigerating and Air-Conditoning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, Georgia 30329.
8. Department of Housing and Urban Development, Washington, D.C. 20410.
9. American Insurance Association, 85 John Street, New York, New York 10038.
10. National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269.
11. American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.
12. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the American Water Works Association (Utilities), 6666 W. Quincy Avenue, Denver, Colorado 80235.
13. Manufacturers Standardization Society of the Valve & Fittings Industry, 5203 Leesburg Pike, Suite 502, Falls Church, Virginia 22041.
14. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or the Manufacturers Standardization Society of the Valve & Fittings Industry, 5203 Leesburg Pike, Suite 502, Falls Church, Virginia 22041.
15. American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or Underwriters Laboratories Inc., Publication Stock, 333 Pfingsten Rd., Northbrook, Illinois 60062.

APPENDIX B

COORDINATION OF GAS UTILIZATION EQUIPMENT DESIGN, CONSTRUCTION AND MAINTENANCE

(This Appendix is informative and is not a part of the Code. This check list may be helpful in the design and selection of gas utilization equipment.)

B1. Coordination.

B1.1 Because industrial gas applications are so varied in nature, many agencies are jointly involved with their safe and satisfactory use. Prior to installation, the specific assignments should be agreed upon by the parties concerned. A typical, but not mandatory, delineation of assignments is given in B1.2 through B1.5, and a detailed check list is given in B2.

B1.2 Person or agency planning an installation of gas equipment:

B1.2.1 Verifies the adequacy of the gas supply, volume, pressure and meter location.

B1.2.2 Determines suitability of gas for the process.

B1.2.3 Notifies gas suppliers of significant changes in requirements.

B1.3 Upon request, the gas supplier furnishes the user complete information on:

B1.3.1 Combustion characteristics and physical or chemical properties such as specific gravity, heating value, pressure and the approximate analysis of the gas.

B1.3.2 Conditions under which an adequate supply of gas at suitable pressure can be brought to the site.

B1.3.3 Continuity of the gas supply.

B1.4 The gas equipment manufacturer or builder provides:

B1.4.1 Design and construction of all gas equipment or assemblies shipped from its plant.

B1.4.2 Design and construction of all gas equipment fabricated, erected or assembled by the gas equipment manufacturer or builder in the field.

B1.4.3 A statement of the maximum hourly Btu input, type of gas and design pressure range.

B1.4.4 Written installation and operating instructions for the user.

B1.5 The person or agency making and the person or agency authorizing the installation of gas equipment (purchaser) jointly:

B1.5.1 Select, erect, or assemble gas equipment, components or designs purchased or developed by that person or agency.

B1.5.2 Assure conformance to codes, ordinances or regulations applicable to the installation.

B1.5.3 Provide adequate means of disposal of products of combustion.

B1.5.4 Initially operate the gas equipment in a safe manner.

B2. Gas Equipment Design and Construction Check List.

B2.1 The basic design and installation should consider:

B2.1.1 Suitability of equipment for process requirements.
B2.1.2 Adequate structural strength and stability.
B2.1.3 Reasonable life expectation.
B2.1.4 Conformance to existing safety standards.
B2.1.5 Adequate combustion space and venting.
B2.1.6 Means for observation and inspection of combustion.

B2.2 Materials of construction used, other than pipe, fittings and valves, should provide reasonable life expectancy for the service intended and be capable of satisfactorily withstanding:

B2.2.1 Operating temperatures.
B2.2.2 Chemical action.
B2.2.3 Thermal shock.
B2.2.4 Load stresses.

B2.3 Combustion systems should be selected for the characteristics of the available gas so that they will operate properly at the elevation at point of use and produce:

B2.3.1 Proper heat distribution.
B2.3.2 Adequate operating temperature range.
B2.3.3 Suitable flame geometry.
B2.3.4 Flame stability.
B2.3.5 Operating flexibility.
B2.3.6 Desired heating chamber atmosphere.

B2.4 Pipe, fittings and valves shall conform to applicable American National Standards as indicated in 2.6. Piping, bushings and material in fittings should not be selected nor used until the following factors have been considered:

B2.4.1 Correct size to handle required volume (consideration of pressure drop in controls and manifolds is particularly important in low pressure systems).

B2.4.2 Material specifications suitable for pressures and temperatures encountered.

B2.4.3 Adequate supports and protection against physical damage.

B2.4.4 Tight assembly and thorough leak inspection.

B2.4.5 Use of sufficient unions and flanges, where permitted, for convenient field replacement or repair.

B2.4.6 Arrangement of piping to provide accessibility for equipment adjustments and freedom from thermal damage.

B2.5 Information concerning the characteristics of the gas and electricity available at the point of utilization should be specific and complete. Gas controls and electrical equipment should be selected to conform to these characteristics which include:

B2.5.1 Gas characteristics: heat content, pressure, specific gravity and approximate analysis.

B2.5.2 Electrical characteristics: voltages, number of phases and frequencies for both control and power circuits.

B2.5.3 Location of electrical equipment and wiring to avoid thermal damage and excessive concentrations of dust, dirt or foreign material.

B2.5.4 Requirements of applicable electrical codes and standards, with particular reference to Article 500 of the National Electrical Code, ANSI/NFPA 70.

B2.6 Temperature controls, if used, should be carefully selected considering:

B2.6.1 Range and type of instruments and sensing elements.

B2.6.2 Type of control action.

B2.6.3 Suitability for service required.

B2.6.4 Correlation of control instruments with operating equipment.

B2.7 In enclosed chambers, the accumulation of gas-air or solvent-air mixtures which may be accidentally ignited constitutes a potential hazard to life and property. For this reason, consideration shall be given to the selection and installation of suitable protective equipment. The selection of a satisfactory protective system and components not otherwise covered by existing codes or standards should be based on the requirements of each individual installation after consultation with the various interested parties, including user, designer, insurance company and local authorities having jurisdiction. Some of the factors and considerations involved in the selection of protective equipment are:

B2.7.1 Feasibility of its installation.

B2.7.2 Its adaptability to process and control requirements.

B2.7.3 Conformance to existing standards, ordinances, requirements and other regulations which apply. (See Appendix A for listing of standards and specifications.)

B3. Maintenance of Gas Equipment.

B3.1 These recommendations are prepared for maintenance of gas equipment. Special types of equipment demand special attention.

B3.2 Burners and pilots should be kept clean and in proper operating condition. Burner refractory parts should be examined at frequent regular intervals to assure good condition.

B3.3 When automatic flame safeguards are used, a complete shutdown and restart should be made at frequent intervals to check the components for proper operation.

B3.4 Other Safeguard Equipment.

B3.4.1 Accessory safeguard equipment, such as manual reset valves with pressure or vacuum switches, high temperature limit switches, draft controls, shutoff valves, air flow switches, door switches and gas valves, should be operated at frequent regular intervals to insure proper functioning. If inoperative, they should be repaired or replaced promptly.

B3.4.2 When fire checks are installed in gas-air mixture piping to prevent flashbacks from traveling farther upstream, the pressure loss across the fire checks should be measured at regular intervals. When excessive pressure loss is found, screens should be removed and cleaned. Water type backfire checks should be inspected at frequent regular intervals and liquid level maintained.

B3.4.3 All safety shutoff valves should be checked for leakage and proper operation at frequent regular intervals.

B3.5 Auxiliary Devices.

B3.5.1 A necessary part of the gas equipment maintenance should be the proper maintenance of auxiliary devices. Maintenance instructions as supplied by the manufacturers of these devices should be followed.

B3.5.2 Gas combustion equipment, including blowers, mechanical mixers, control valves, temperature control instruments, air valves and air filters, should be kept clean and should be examined at frequent regular intervals.

B3.5.3 Necessary repairs and replacements should be made promptly.

B3.6 Regulator and zero governor vents and impulse or control piping and tubing should be kept clear. Regulator valves which operate improperly should be cleaned, repaired or replaced promptly.

B3.7 A necessary part of the gas equipment maintenance should be the proper maintenance of the gas piping system. It is recommended that gas piping be inspected and tested for leakage at regular intervals in accordance with the provisions of 4.1.5. Air piping should be kept internally clean to prevent accumulation of dust, lint and grease in air jets and valves. Where conditions warrant, filters should be installed at the intake to the fans.

B3.8 Stand-by or substitute fuel equipment and systems for gas equipment should be kept in good operating condition and tested periodically.

B3.9 An adequate supply of repair parts should be maintained.

APPENDIX C

SIZING AND CAPACITIES OF GAS PIPING

(This Appendix is informative and is not a part of the Code.)

In order to determine the size of piping to be used in designing a gas piping system, the following factors must be considered:

a. Allowable loss in pressure from point of delivery to equipment.
b. Maximum gas demand.
c. Length of piping and number of fittings.
d. Specific gravity of the gas.
e. Diversity factor.

For any gas piping system, for special gas utilization equipment or for conditions other than those covered by Tables C-3 through C-6, C-16 or C-17, such as longer runs, greater gas demands or greater pressure drops, the size of each gas piping system should be determined by standard engineering practices acceptable to the authority having jurisdiction.

Description of Tables

a. The quantity of gas to be provided at each outlet should be determined, whenever possible, directly from the manufacturer's Btu input rating of the equipment which will be installed. In case the ratings of the equipment to be installed are not known, Table C-1 shows the approximate consumption of average appliances of certain types in Btu per hour.

To obtain the cubic feet per hour of gas required, divide the total Btu input of all equipment by the average Btu heating value per cubic foot of the gas. The average Btu per cubic foot of the gas in the area of the installation may be obtained from the serving gas supplier.

b. Capacities for gas at low pressures (0.5 psig or less) in cubic feet per hour of 0.60 specific gravity gas for different sizes and lengths are shown in Tables C-3 and C-4 for iron pipe or equivalent rigid pipe and in Tables C-5 and C-6 for semi-rigid tubing. Tables C-3 and C-5 are based upon a pressure drop of 0.3 inch water column, whereas Tables C-4 and C-6 are based upon a pressure drop of 0.5 inch water column. In using these Tables no additional allowance is necessary for an ordinary number of fittings.

c. Capacities in thousands of Btu per hour of undiluted liquefied petroleum gases based on a pressure drop of 0.5 inch water column for different sizes and lengths are shown in Table C-16 for iron pipe or equivalent rigid pipe and in Table C-17 for semi-rigid tubing. In using these tables, no additional allowance is necessary for an ordinary number of fittings.

d. Gas piping systems that are to be supplied with gas of a specific gravity of 0.70 or less can be sized directly from Tables C-3 through C-6, unless the authority having jurisdiction specifies that a gravity factor be applied. When the specific gravity of the gas is greater than 0.70, the gravity factor shall be applied.

Application of the gravity factor converts the figures given in Tables C-3 through C-6 to capacities with another gas of different specific gravity. Such application is accomplished by multiplying the capacities given in Tables C-3 through C-6 by the multipliers shown in Table C-15. In case the exact specific gravity does not appear in the Table, choose the next higher value specific gravity shown.

Use of Capacity Tables

To determine the size of each section of gas piping in a system within the range of the capacity tables, proceed as follows: (Also see sample calculation at end of Appendix C.)

1. Determine the gas demand of each appliance to be attached to the piping system. When Tables C-3 through C-6 are to be used to select the piping size, calculate the gas demand in terms of cubic feet per hour for each piping system outlet. When Tables C-16 or C-17 are to be used to select the piping size, calculate the gas demand in terms of thousands of Btu per hour for each piping system outlet.
2. When the piping system is for use with other than undiluted liquefied petroleum gases, determine the design system pressure, the allowable loss in pressure (pressure drop), and the specific gravity of the gas to be used in the piping system.
3. Measure the length of piping from the point of delivery to the most remote outlet in the building.
4. In the appropriate capacity table, select the column showing the measured length, or the next longer length if the table does not give the exact length. This is the only length used in determining the size of any section of gas piping. If the gravity factor is to be applied, the values in the selected column of the table are multiplied by the appropriate multiplier from Table C-15.

Capacities may also be determined by using the following formulae:*

High Pressure (1.5 psig and above):

$$Q = 181.6 \sqrt{\frac{D^5 \cdot (P_1^2 - P_2^2) \cdot Y}{Cr \cdot fba \cdot L}}$$

$$= 2237\ D^{2.623} \left[\frac{(P_1^2 - P_2^2) \cdot Y}{Cr \cdot L}\right]^{0.541}$$

Low Pressure (less than 1.5 psig):

$$Q = 187.3 \sqrt{\frac{D^5 \cdot \Delta H}{Cr \cdot fba \cdot L}}$$

$$= 2313\ D^{2.623} \left(\frac{\Delta H}{Cr \cdot L}\right)^{0.541}$$

where

Q = Rate, cu ft per hr at 60 F and 30 in. mercury column

D = Inside diameter of pipe, in.

P_1 = Upstream pressure, psia

P_2 = Downstream pressure, psia

Y = Superexpansibility factor† = 1/supercompressibility factor

Cr = Factor for viscosity, density and temperature

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*For further details on the formulae, refer to "Polyflo Flow Computer," B. C. Shebeko, 1974, available from Polyflo Computer Company, Box 50126, Dallas, Texas 75250.

†For values for natural gas, refer to "Manual for Determination of Supercompressibility Factors for Natural Gas," available from American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

For values for liquefied petroleum gases, refer to "Engineering Data Book," available from Gas Processors Association, 1812 First Place, Tulsa, Oklahoma 74102.

$$= 0.00354\ ST\left(\frac{Z}{S}\right)^{.152}$$

S = Specific gravity of gas at 60 F and 30 in. mercury column

T = Absolute temperature, F or

= t + 460

t = Temperature, F

Z = Viscosity of gas, centipoise (0.012 for natural gas, 0.008 for propane), or

= 1488 μ

μ = Viscosity, pounds per second ft

fba = Base friction factor for air at 60 F (CF = 1)

L = Length of pipe, ft

ΔH = Pressure drop, in. water column (27.7" H_20 = 1 psi)

CF = Factor CF $= \left(\frac{fb}{fba}\right)$

fb = Base friction factor for any fluid at a given temperature, F

5. Use this vertical column to locate ALL gas demand figures for this particular system of piping.

6. Starting at the most remote outlet, find in the vertical column just selected the gas demand for that outlet. If the exact figure of demand is not shown, choose the next larger figure below in the column.

7. Opposite this demand figure, in the first column at the left, will be found the correct size of gas piping.

8. Proceed in a similar manner for each outlet and each section of gas piping. For each section of piping determine the total gas demand supplied by that section.

Table C-1

Approximate Gas Input for Typical Appliances

Appliance	Input Btu per hr. (Approx.)
Range, Free Standing, Domestic	65,000
Built-In Oven or Broiler Unit, Domestic	25,000
Built-In Top Unit, Domestic	40,000
Water Heater, Automatic Storage 30 to 40 Gal. Tank	45,000
Water Heater, Automatic Storage 50 Gal. Tank	55,000
Water Heater, Automatic Instantaneous	
(2 gal. per minute	142,800
Capacity (4 gal. per minute	285,000
(6 gal. per minute	428,400
Water Heater, Domestic, Circulating or Side-Arm	35,000
Refrigerator	3,000
Clothes Dryer, Type 1 (Domestic)	35,000
Gas Light	2,500
Incinerator, Domestic	35,000

For specific appliances or appliances not shown above, the input should be determined from the manufacturer's rating.

Table C-2

Equivalent Lengths, in Feet of Straight Pipe, of Bends, Fittings and Valves

The equivalent lengths in feet shown in Table C-2* have been computed on a basis that the inside diameter corresponds to that of Schedule 40 (standard-weight) steel pipe which is close enough for most purposes involving other schedules of pipe. Where a more specific solution for equivalent length is desired, this may be made by multiplying the actual inside diameter of the pipe in inches by n/12, or the actual inside diameter in feet by n. N can be read from the table heading. The equivalent length values can be used with reasonable accuracy for copper or brass fittings and bends. For copper or brass valves, however, the equivalent length of pipe should be taken as 45 percent longer than the values in the table which are for steel pipe. Resistance per foot of copper or brass pipe is less than that of steel.

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*From PIPING HANDBOOK, by Sabin Crocker, 4th Ed., Copyright, 1945 by McGraw-Hill, Inc., Table XIV, pp. 100-101. Used by permission of McGraw-Hill Book Company.

Table C-2

		Screwed fittings[2]				90° welding elbows and smooth bends[3]					
		45° ell	90° ell	180° close return bends	Tee	R/d = 1	R/d = 1½	R/d = 2	R/d = 4	R/d = 6	R/d = 8
k factor =		0.42	0.90	2.00	1.80	0.48	0.36	0.27	0.21	0.27	0.36
L/d' ratio[5] n =		14	30	67	60	16	12	9	7	9	12
Nominal pipe size, in.	Inside diam. d, in., Sched. 40[7]										
		L = equivalent length in feet of Schedule 40 (standard weight) straight pipe[7]									
½	0.622	0.73	1.55	3.47	3.10	0.83	0.62	0.47	0.36	0.47	0.62
¾	0.824	0.96	2.06	4.60	4.12	1.10	0.82	0.62	0.48	0.62	0.82
1	1.049	1.22	2.62	5.82	5.24	1.40	1.05	0.79	0.61	0.79	1.05
1¼	1.380	1.61	3.45	7.66	6.90	1.84	1.38	1.03	0.81	1.03	1.38
1½	1.610	1.88	4.02	8.95	8.04	2.14	1.61	1.21	0.94	1.21	1.61
2	2.067	2.41	5.17	11.5	10.3	2.76	2.07	1.55	1.21	1.55	2.07
2½	2.469	2.88	6.16	13.7	12.3	3.29	2.47	1.85	1.44	1.85	2.47
3	3.068	3.58	7.67	17.1	15.3	4.09	3.07	2.30	1.79	2.30	3.07
4	4.026	4.70	10.1	22.4	20.2	5.37	4.03	3.02	2.35	3.02	4.03
5	5.047	5.88	12.6	28.0	25.2	6.72	5.05	3.78	2.94	3.78	5.05
6	6.065	7.07	15.2	33.8	30.4	8.09	6.07	4.55	3.54	4.55	6.07
8	7.981	9.31	20.0	44.6	40.0	10.6	7.98	5.98	4.65	5.98	7.98
10	10.02	11.7	25.0	55.7	50.0	13.3	10.0	7.51	5.85	7.51	10.0
12	11.94	13.9	29.8	66.3	59.6	15.9	11.9	8.95	6.96	8.95	11.9
14	13.13	15.3	32.8	73.0	65.6	17.5	13.1	9.85	7.65	9.85	13.1
16	15.00	17.5	37.5	83.5.	75.0	20.0	15.0	11.2	8.75	11.2	15.0
18	16.88	19.7	42.1	93.8	84.2	22.5	16.9	12.7	9.85	12.7	16.9
20	18.81	22.0	47.0	105	94.0	25.1	18.8	14.1	11.0	14.1	18.8
24	22.63	26.4	56.6	126	113	30.2	22.6	17.0	13.2	17.0	22.6

1. Values for welded fittings are for conditions where bore is not obstructed by weld spatter or backing rings. If appreciably obstructed, use values for "Screwed Fittings."
2. Flanged fittings have three-fourths the resistance of screwed elbows and tees.
3. Tabular figures give the extra resistance due to curvature alone to which should be added the full length of travel.
4. Small size socket-welding fittings are equivalent to miter elbows and miter tees.

Table C-2 (Continued)

Miter elbows[4] (No. of miters)					Welding tees		Valves (screwed, flanged, or welded)			
1-45°	1-60°	1-90°	2-90°	3-90°	Forged	Miter[4]	Gate	Globe	Angle	Swing check
0.45	0.90	1.80	0.60	0.45	1.35	1.80	0.21	10	5.0	2.5
15	30	60	20	15	45	60	7	333	167	83
			[6]	[6]						
L = equivalent length in feet of Schedule 40 (standard weight) straight pipe[7]										
0.78	1.55	3.10	1.04	0.78	2.33	3.10	0.36	17.3	8.65	4.32
1.03	2.06	4.12	1.37	1.03	3.09	4.12	0.48	22.9	11.4	5.72
1.31	2.62	5.24	1.75	1.31	3.93	5.24	0.61	29.1	14.6	7.27
1.72	3.45	6.90	2.30	1.72	5.17	6.90	0.81	38.3	19.1	9.58
2.01	4.02	8.04	2.68	2.01	6.04	8.04	0.94	44.7	22.4	11.2
2.58	5.17	10.3	3.45	2.58	7.75	10.3	1.21	57.4	28.7	14.4
3.08	6.16	12.3	4.11	3.08	9.25	12.3	1.44	68.5	34.3	17.1
3.84	7.67	15.3	5.11	3.84	11.5	15.3	1.79	85.2	42.6	21.3
5.04	10.1	20.2	6.71	5.04	15.1	20.2	2.35	112	56.0	28.0
6.30	12.6	25.2	8.40	6.30	18.9	25.2	2.94	140	70.0	35.0
7.58	15.2	30.4	10.1	7.58	22.8	30.4	3.54	168	84.1	42.1
9.97	20.0	40.0	13.3	9.97	29.9	40.0	4.65	222	111	55.5
12.5	25.0	50.0	16.7	12.5	37.6	50.0	5.85	278	139	69.5
14.9	29.8	59.6	19.9	14.9	44.8	59.6	6.96	332	166	83.0
16.4	32.8	65.6	21.9	16.4	49.2	65.6	7.65	364	182	91.0
18.8	37.5	75.0	25.0	18.8	56.2	75.0	8.75	417	208	104
21.1	42.1	84.2	28.1	21.1	63.2	84.2	9.85	469	234	117
23.5	47.0	94.0	31.4	23.5	70.6	94.0	11.0	522	261	131
28.3	56.6	113	37.8	28.3	85.0	113	13.2	629	314	157

5. Equivalent resistance in number of diameters of straight pipe computed for a value of *f* — 0.0075 from the relation *n* — *k*/4*f*.
6. For condition of minimum resistance where the center-line length of each miter is between *d* and 2½ *d*.
7. For pipe having other inside diameters, the equivalent resistance may be computed from the above *n* values.

Table C-3

Maximum Capacity of Pipe in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.3 Inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/4	.364	32	22	18	15	14	12	11	11	10	9	8	8	7	6
3/8	.493	72	49	40	34	30	27	25	23	22	21	18	17	15	14
1/2	.622	132	92	73	63	56	50	46	43	40	38	34	31	28	26
3/4	.824	278	190	152	130	115	105	96	90	84	79	72	64	59	55
1	1.049	520	350	285	245	215	195	180	170	160	150	130	120	110	100
1 1/4	1.380	1,050	730	590	500	440	400	370	350	320	305	275	250	225	210
1 1/2	1.610	1,600	1,100	890	760	670	610	560	530	490	460	410	380	350	320
2	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	870	780	710	650	610
2 1/2	2.469	4,800	3,300	2,700	2,300	2,000	1,850	1,700	1,600	1,500	1,400	1,250	1,130	1,050	980
3	3.068	8,500	5,900	4,700	4,100	3,600	3,250	3,000	2,800	2,600	2,500	2,200	2,000	1,850	1,700
4	4.026	17,500	12,000	9,700	8,300	7,400	6,800	6,200	5,800	5,400	5,100	4,500	4,100	3,800	3,500

Table C-4

Maximum Capacity of Pipe in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.5 Inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
¼	.364	43	29	24	20	18	16	15	14	13	12	11	10	9	8
⅜	.493	95	65	52	45	40	36	33	31	29	27	24	22	20	19
½	.622	175	120	97	82	73	66	61	57	53	50	44	40	37	35
¾	.824	360	250	200	170	151	138	125	118	110	103	93	84	77	72
1	1.049	680	465	375	320	285	260	240	220	205	195	175	160	145	135
1¼	1.380	1,400	950	770	660	580	530	490	460	430	400	360	325	300	280
1½	1.610	2,100	1,460	1,180	990	900	810	750	690	650	620	550	500	460	430
2	2.067	3,950	2,750	2,200	1,900	1,680	1,520	1,400	1,300	1,220	1,150	1,020	950	850	800
2½	2.469	6,300	4,350	3,520	3,000	2,650	2,400	2,250	2,050	1,950	1,850	1,650	1,500	1,370	1,280
3	3.068	11,000	7,700	6,250	5,300	4,750	4,300	3,900	3,700	3,450	3,250	2,950	2,650	2,450	2,280
4	4.026	23,000	15,800	12,800	10,900	9,700	8,800	8,100	7,500	7,200	6,700	6,000	5,500	5,000	4,600

Table C-5

Maximum Capacity of Semi-Rigid Tubing in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.3 Inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Outside Diameter, Inch	Length of Tubing, Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
⅜	20	14	11	10	9	8	7	7	6	6	5	5	4	4
½	42	29	23	20	18	16	15	14	13	12	11	10	9	8
⅝	86	59	47	40	36	33	30	28	26	25	22	20	18	17
¾	150	103	83	71	63	57	52	49	46	43	38	35	32	30
⅞	212	146	117	100	89	81	74	69	65	61	54	49	45	42

Table C-6

Maximum Capacity of Semi-Rigid Tubing in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.5 Inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Outside Diameter, Inch	Length of Tubing, Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
⅜	27	18	15	13	11	10	9	9	8	8	7	6	6	5
½	56	38	31	26	23	21	19	18	17	16	14	13	12	11
⅝	113	78	62	53	47	43	39	37	34	33	29	26	24	22
¾	197	136	109	93	83	75	69	64	60	57	50	46	42	39
⅞	280	193	155	132	117	106	98	91	85	81	71	65	60	55

Table C-7

Pipe Sizing Table for Pressures Under 1 Pound Approximate Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour With Pressure Drop of 0.3 Inch Water Column and 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	215	148	119	102	90	82	70	62	43	34	29
1.25	1.380	442	304	244	209	185	168	143	127	87	70	60
1.50	1.610	662	455	366	313	277	251	215	191	131	105	90
2.00	2.067	1275	877	704	602	534	484	414	367	252	203	173
2.50	2.469	2033	1397	1122	960	851	771	660	585	402	323	276
3.00	3.068	3594	2470	1983	1698	1505	1363	1167	1034	711	571	488
3.50	3.548	5262	3616	2904	2485	2203	1996	1708	1514	1041	836	715
4.00	4.026	7330	5038	4046	3462	3069	2780	2380	2109	1450	1164	996
5.00	5.047	13261	9114	7319	6264	5552	5030	4305	3816	2623	2106	1802
6.00	6.065	21472	14758	11851	10143	8990	8145	6971	6178	4246	3410	2919
8.00	7.981	44118	30322	24350	20840	18470	16735	14323	12694	8725	7006	5997
10.00	10.020	80130	55073	44225	37851	33547	30396	26015	23056	15847	12725	10891
12.00	11.938	126855	87187	70014	59923	53109	48120	41185	36501	25087	20146	17242

Table C-8

Pipe Sizing Table for Pressures Under 1 Pound Approximate Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour With Pressure Drop of 0.5 Inch Water Column and 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	284	195	157	134	119	108	92	82	56	45	39
1.25	1.380	583	400	322	275	244	221	189	168	115	93	79
1.50	1.610	873	600	482	412	366	331	283	251	173	139	119
2.00	2.067	1681	1156	928	794	704	638	546	484	333	267	229
2.50	2.469	2680	1842	1479	1266	1122	1017	870	771	530	426	364
3.00	3.068	4738	3256	2615	2238	1983	1797	1538	1363	937	752	644
3.50	3.548	6937	4767	3828	3277	2904	2631	2252	1996	1372	1102	943
4.00	4.026	9663	6641	5333	4565	4046	3666	3137	2780	1911	1535	1313
5.00	5.047	17482	12015	9649	8258	7319	6632	5676	5030	3457	2776	2376
6.00	6.065	28308	19456	15624	13372	11851	10738	9190	8145	5598	4496	3848
8.00	7.981	58161	39974	32100	27474	24350	22062	18883	16735	11502	9237	7905
10.00	10.020	105636	72603	58303	49900	44225	40071	34296	30396	20891	16776	14358
12.00	11.938	167236	114940	92301	78998	70014	63438	54295	48120	33073	26559	22731

Table C-9

Pipe Sizing Table for 1 Pound Pressure
Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 1.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	717	493	396	338	300	272	233	206	142	114	97
1.25	1.380	1471	1011	812	695	616	558	478	423	291	234	200
1.50	1.610	2204	1515	1217	1041	923	836	716	634	436	350	300
2.00	2.067	4245	2918	2343	2005	1777	1610	1378	1222	840	674	577
2.50	2.469	6766	4651	3735	3196	2833	2567	2197	1947	1338	1075	920
3.00	3.068	11962	8221	6602	5650	5008	4538	3884	3442	2366	1900	1626
3.50	3.548	17514	12037	9666	8273	7332	6644	5686	5039	3464	2781	2381
4.00	4.026	24398	16769	13466	11525	10214	9255	7921	7020	4825	3875	3316
5.00	5.047	44140	30337	24362	20851	18479	16744	14330	12701	8729	7010	6000
6.00	6.065	71473	49123	39447	33762	29923	27112	23204	20566	14135	11351	9715
8.00	7.981	146849	100929	81049	69368	61479	55705	47676	42254	29041	23321	19960
10.00	10.020	266718	183314	147207	125990	111663	101175	86592	76745	52747	42357	36252
12.00	11.938	422248	290209	233048	199459	176777	160172	137087	121498	83505	67057	57392

Table C-10

Pipe Sizing Table for 2 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 2.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	1112	764	614	525	466	422	361	320	220	177	151
1.25	1.380	2283	1569	1260	1079	956	866	741	657	452	363	310
1.50	1.610	3421	2351	1888	1616	1432	1298	1111	984	677	543	465
2.00	2.067	6589	4528	3636	3112	2758	2499	2139	1896	1303	1046	896
2.50	2.469	10501	7217	5796	4961	4396	3983	3409	3022	2077	1668	1427
3.00	3.068	18564	12759	10246	8769	7772	7042	6027	5342	3671	2948	2523
3.50	3.548	27181	18681	15002	12840	11379	10311	8825	7821	5375	4317	3694
4.00	4.026	37865	26025	20899	17887	15853	14364	12293	10895	7488	6013	5147
5.00	5.047	68504	47082	37809	32359	28680	25986	22240	19711	13547	10879	9311
6.00	6.065	110924	76237	61221	52397	46439	42077	36012	31917	21936	17616	15077
8.00	7.981	227906	156638	125786	107657	95414	86452	73992	65578	45071	36194	30977
10.00	10.020	413937	284497	228461	195533	173297	157020	134389	119106	81861	65737	56263
12.00	11.938	655315	450394	361682	309553	274351	248582	212754	188560	129596	104070	89071

Table C-11

Pipe Sizing Table for 5 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 5.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	1989	1367	1098	940	833	755	646	572	393	316	270
1.25	1.380	4084	2807	2254	1929	1710	1549	1326	1175	808	649	555
1.50	1.610	6120	4206	3378	2891	2562	2321	1987	1761	1210	972	832
2.00	2.067	11786	8101	6505	5567	4934	4471	3827	3391	2331	1872	1602
2.50	2.469	18785	12911	10368	8874	7865	7126	6099	5405	3715	2983	2553
3.00	3.068	33209	22824	18329	15687	13903	12597	10782	9556	6568	5274	4514
3.50	3.548	48623	33418	26836	22968	20356	18444	15786	13991	9616	7722	6609
4.00	4.026	67736	46555	37385	31997	28358	25694	21991	19490	13396	10757	9207
5.00	5.047	122544	84224	67635	57887	51304	46485	39785	35261	24235	19461	16656
6.00	6.065	198427	136378	109516	93732	83073	75270	64421	57095	39241	31512	26970
8.00	7.981	407692	280204	225014	192583	170683	154651	132361	117309	80626	64745	55414
10.00	10.020	740477	508926	408686	349782	310005	280887	240403	213065	146438	117595	100646
12.00	11.938	1172269	805694	647001	553749	490777	444680	380588	337309	231830	186168	159336

Table C-12

Pipe Sizing Table for 10 Pounds Pressure
Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 10.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	3259	2240	1798	1539	1364	1236	1058	938	644	517	443
1.25	1.380	6690	4598	3692	3160	2801	2538	2172	1925	1323	1062	909
1.50	1.610	10024	6889	5532	4735	4197	3802	3254	2884	1982	1592	1362
2.00	2.067	19305	13268	10655	9119	8082	7323	6268	5555	3818	3066	2624
2.50	2.469	30769	21148	16982	14535	12882	11672	9990	8854	6085	4886	4182
3.00	3.068	54395	37385	30022	25695	22773	20634	17660	15652	10757	8638	7393
3.50	3.548	79642	54737	43956	37621	33343	30211	25857	22916	15750	12648	10825
4.00	4.026	110948	76254	61235	52409	46449	42086	36020	31924	21941	17620	15080
5.00	5.047	200720	137954	110782	94815	84033	76140	65166	57755	39695	31876	27282
6.00	6.065	325013	223379	179382	153527	136068	123288	105518	93519	64275	51615	44176
8.00	7.981	667777	458959	368561	315440	279569	253310	216800	192146	132061	106050	90765
10.00	10.020	1212861	833593	669404	572924	507772	460078	393767	348988	239858	192614	164853
12.00	11.938	1920112	1319682	1059751	907010	803866	728361	623383	552493	379725	304933	260983

Table C-13

Pipe Sizing Table for 20 Pounds Pressure
Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 20.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	5674	3900	3132	2680	2375	2152	1842	1633	1122	901	771
1.25	1.380	11649	8006	6429	5503	4877	4419	3782	3352	2304	1850	1583
1.50	1.610	17454	11996	9633	8245	7307	6621	5667	5022	3452	2772	2372
2.00	2.067	33615	23103	18553	15879	14073	12751	10913	9672	6648	5338	4569
2.50	2.469	53577	36823	29570	25308	22430	20323	17394	15416	10595	8509	7282
3.00	3.068	94714	65097	52275	44741	39653	35928	30750	27253	18731	15042	12874
3.50	3.548	138676	95311	76538	65507	58058	52604	45023	39903	27425	22023	18849
4.00	4.026	193187	132777	106624	91257	80879	73282	62720	55538	38205	30680	26258
5.00	5.047	349503	240211	192898	165096	146322	132578	113470	100566	69118	55505	47505
6.00	6.065	565926	388958	312347	267329	236928	214674	183733	162840	111919	89875	76921
8.00	7.981	1162762	799160	641754	549258	486797	441074	377502	334573	229950	184658	158043
10.00	10.020	2111887	1451488	1165596	997600	884154	801108	685645	607674	417651	335388	287049
12.00	11.938	3343383	2297888	1845285	1579326	1399727	1268254	1085462	962025	661194	530962	454435

Table C-14

Pipe Sizing Table for 50 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 50.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	12993	8930	7171	6138	5440	4929	4218	3739	2570	2063	1766
1.25	1.380	26676	18335	14723	12601	11168	10119	8661	7676	5276	4236	3626
1.50	1.610	39970	27471	22060	18881	16733	15162	12976	11501	7904	6348	5433
2.00	2.067	76977	52906	42485	36362	32227	29200	24991	22149	15223	12225	10463
2.50	2.469	122690	84324	67715	57955	51365	46540	39832	35303	24263	19484	16676
3.00	3.068	216893	149070	119708	102455	90804	82275	70417	62409	42893	34445	29480
3.50	3.548	317564	218260	175271	150009	132950	120463	103100	91376	62802	50432	43164
4.00	4.026	442393	304054	244166	208975	185211	167814	143627	127294	87489	70256	60130
5.00	5.047	800352	550077	441732	378065	335072	303600	259842	230293	158279	127104	108784
6.00	6.065	1295955	890703	715266	612175	542559	491598	420744	372898	256291	205810	176147
8.00	7.981	2662693	1830054	1469598	1257785	1114752	1010046	864469	766163	526579	422862	361915
10.00	10.020	4836161	3323866	2669182	2284474	2024687	1834514	1570106	1391556	956409	768030	657334
12.00	11.938	7656252	5262099	4225651	3616611	3205335	2904266	2485676	2203009	1514115	1215888	1040643

Table C-15

Multipliers To Be Used with Tables C-3 through C-14 When the Specific Gravity of the Gas Is Other Than 0.60

Specific Gravity	Multiplier	Specific Gravity	Multiplier
.35	1.31	1.00	.78
.40	1.23	1.10	.74
.45	1.16	1.20	.71
.50	1.10	1.30	.68
.55	1.04	1.40	.66
.60	1.00	1.50	.63
.65	.96	1.60	.61
.70	.93	1.70	.59
.75	.90	1.80	.58
.80	.87	1.90	.56
.85	.84	2.00	.55
.90	.82	2.10	.54

Table C-16

Maximum Capacity of Pipe in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases (at 11 Inches Water Column Inlet Pressure)

(Based on a Pressure Drop of 0.5 Inch Water Column)

Nominal Iron Pipe Size, Inches	Length of Pipe, Feet											
	10	20	30	40	50	60	70	80	90	100	125	150
½	275	189	152	129	114	103	96	89	83	78	69	63
¾	567	393	315	267	237	217	196	185	173	162	146	132
1	1071	732	590	504	448	409	378	346	322	307	275	252
1¼	2205	1496	1212	1039	913	834	771	724	677	630	567	511
1½	3307	2299	1858	1559	1417	1275	1181	1086	1023	976	866	787
2	6221	4331	3465	2992	2646	2394	2205	2047	1921	1811	1606	1496

Table C-17

Maximum Capacity of Semi-Rigid Tubing in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases (at 11 Inches Water Column Inlet Pressure)

(Based on a Pressure Drop of 0.5 Inch Water Column)

Outside Diameter, Inch	Length of Tubing, Feet									
	10	20	30	40	50	60	70	80	90	100
3/8	39	26	21	19	—	—	—	—	—	—
1/2	92	62	50	41	37	35	31	29	27	26
5/8	199	131	107	90	79	72	67	62	59	55
3/4	329	216	181	145	131	121	112	104	95	90
7/8	501	346	277	233	198	187	164	155	146	138

Example of Piping System Design:

Determine the required pipe size of each section and outlet of the piping system shown in Exhibit 1, with a designated pressure drop of 0.50 inch water column. Gas to be used has 0.65 specific gravity and a heating value of 1,000 Btu per cubic foot.

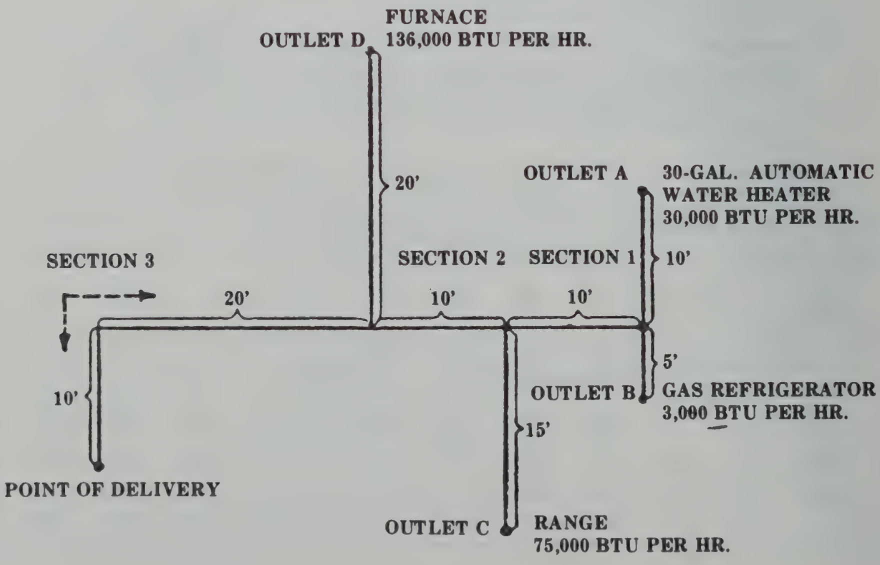

Exhibit 1.

Solution:

(1) Maximum gas demand for outlet A:

$$\frac{\text{Consumption (rating plate input, or Table C-1 if necessary)}}{\text{Btu of gas}} =$$

$$\frac{\text{30,000 Btu per hour rating}}{\text{1,000 Btu per cubic foot}} = \frac{\text{30 cubic feet per hour}}{\text{(or 30 cfh)}}$$

Maximum gas demand for outlet B:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{3{,}000}{1{,}000} = 3 \text{ cfh}$$

Maximum gas demand for outlet C:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{75{,}000}{1{,}000} = 75 \text{ cfh}$$

Maximum gas demand for outlet D:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{136{,}000}{1{,}000} = 136 \text{ cfh}$$

(2) The length of pipe from the point of delivery to the most remote outlet (A) is 60 feet. This is the only distance used.

(3) Using the column marked 60 feet in Table C-4:

Outlet A, supplying 30 cfh, requires ⅜ inch pipe.
Outlet B, supplying 3 cfh, requires ¼ inch pipe.
Section 1, supplying outlets A and B, or 33 cfh, requires ⅜ inch pipe.
Outlet C, supplying 75 cfh, requires ¾ inch pipe.
Section 2, supplying outlets A, B and C, or 108 cfh, requires ¾ inch pipe.
Outlet D, supplying 136 cfh, requires ¾ inch pipe.
Section 3, supplying outlets A, B, C and D, or 244 cfh, requires 1 inch pipe.

(4) If the gravity factor (see (d) under Description of Tables) is applied to this example, the values in the column marked 60 feet of Table C-4 would be multiplied by the multiplier (.962) from Table C-15 and the resulting cubic feet per hour values would be used to size the piping.

APPENDIX D

SUGGESTED METHOD FOR CHECKING FOR LEAKAGE

(This Appendix is informative and is not a part of the Code.)

Use of Lights: Artificial illumination used in connection with a search for gas leakage shall be restricted to battery-operated flashlights (preferably of the safety type) or approved safety lamps. In searching for leaks, electric switches should not be operated. If electric lights are already turned on, they should not be turned off.

a. Checking for Leakage Using the Gas Meter. Immediately prior to the test it should be determined that the meter is in operating condition and has not been bypassed.

Checking for leakage can be done by carefully watching the test dial of the meter to determine whether gas is passing through the meter. To assist in observing any movement of the test hand, wet a small piece of paper and paste its edge directly over the center line of the hand as soon as the gas is turned on. Allow 5 minutes for a ½-foot dial and proportionately longer for a larger dial in checking for gas flow. This observation should be made with the test hand on the upstroke.

In case careful observation of the test hand for a sufficient length of time reveals no movement, the piping shall be purged and a small gas burner turned on and lighted and the hand of the test dial again observed. If the dial hand moves (as it should), it will show that the meter is operating properly. If the test hand does not move or register flow of gas through the meter to the small burner, the meter is defective and the gas should be shut off and the serving gas supplier notified.

b. Checking for Leakage Not Using a Meter. This can be done in two ways: (1) by attaching to an appliance orifice a manometer or equivalent device calibrated so that it can be read in increments of not more than 2 percent of operating system pressure, and momentarily turning on the gas supply and observing the gaging device for pressure drop with the gas supply shut off. No discernible drop in pressure shall occur during a period of 3 minutes; or (2) by inserting a pressure gage between the container gas shutoff valve and the first regulator in the system, admitting full container pressure to the system and then closing the container shutoff valve. An appliance valve shall then be opened momentarily dropping the pressure in th system between the first regulator and the container shutoff valve 10 psi. The system shall then be allowed to stand for 10 minutes without showing an increase or a decrease in the pressure gage reading.

c. **When Leakage is Indicated.** If the meter test hand moves, or a pressure drop on the gage is noted, all equipment or outlets supplied through the system shall be examined to see if they are shut off and do not leak. If they are found tight there is a leak in the piping system.

APPENDIX E

SUGGESTED EMERGENCY PROCEDURE FOR GAS LEAKS

(This Appendix is informative and is not a part of the Code.)

When an investigation discloses a concentration of gas inside of a building, it is suggested the following immediate actions be taken.

a. Clear the room, building or area of all occupants.

b. Ventilate the affected portion of the building by opening windows and doors.

c. Use every practical means to eliminate sources of ignition. Take precautions to prevent smoking, striking matches, operating electrical switches or devices, opening furnace doors, etc. If possible, cut off all electric circuits at a remote source to eliminate operation of automatic switches in the dangerous area. Safety flashlights designed for use in hazardous atmospheres are recommended for use in such emergencies.

d. Shut off the supply of gas to the areas involved.

e. Investigate other buildings in the immediate area to determine the presence of escaping gas therein.

f. Notify all personnel in the area and the gas supplier from a telephone remote from the area of the leak.

APPENDIX F
FLOW OF GAS THROUGH FIXED ORIFICES

(This Appendix is informative and is not a part of the Code.)

Table F-1
Utility Gases

(Cubic feet per hour at sea level)

Specific Gravity = 0.60
Orifice Coefficient = 0.90
For utility gases of another specific gravity, select multiplier from Table F-3.
For altitudes above 2,000 feet, first select the equivalent orifice size at sea level from Table F-4.

Orifice or Drill Size	Pressure at Orifice—Inches Water Column								
	3	3.5	4	5	6	7	8	9	10
80	.48	.52	.55	.63	.69	.73	.79	.83	.88
79	.55	.59	.64	.72	.80	.84	.90	.97	1.01
78	.70	.76	.78	.88	.97	1.04	1.10	1.17	1.24
77	.88	.95	.99	1.11	1.23	1.31	1.38	1.47	1.55
76	1.05	1.13	1.21	1.37	1.52	1.61	1.72	1.83	1.92
75	1.16	1.25	1.34	1.52	1.64	1.79	1.91	2.04	2.14
74	1.33	1.44	1.55	1.74	1.91	2.05	2.18	2.32	2.44
73	1.51	1.63	1.76	1.99	2.17	2.32	2.48	2.64	2.78
72	1.64	1.77	1.90	2.15	2.40	2.52	2.69	2.86	3.00
71	1.82	1.97	2.06	2.33	2.54	2.73	2.91	3.11	3.26
70	2.06	2.22	2.39	2.70	2.97	3.16	3.38	3.59	3.78
69	2.25	2.43	2.61	2.96	3.23	3.47	3.68	3.94	4.14
68	2.52	2.72	2.93	3.26	3.58	3.88	4.14	4.41	4.64
67	2.69	2.91	3.12	3.52	3.87	4.13	4.41	4.69	4.94
66	2.86	3.09	3.32	3.75	4.11	4.39	4.68	4.98	5.24
65	3.14	3.39	3.72	4.28	4.62	4.84	5.16	5.50	5.78
64	3.41	3.68	4.14	4.48	4.91	5.23	5.59	5.95	6.26
63	3.63	3.92	4.19	4.75	5.19	5.55	5.92	6.30	6.63
62	3.78	4.08	4.39	4.96	5.42	5.81	6.20	6.59	6.94
61	4.02	4.34	4.66	5.27	5.77	6.15	6.57	7.00	7.37
60	4.21	4.55	4.89	5.52	5.95	6.47	6.91	7.35	7.74
59	4.41	4.76	5.11	5.78	6.35	6.78	7.25	7.71	8.11
58	4.66	5.03	5.39	6.10	6.68	7.13	7.62	8.11	8.53
57	4.84	5.23	5.63	6.36	6.96	7.44	7.94	8.46	8.90
56	5.68	6.13	6.58	7.35	8.03	8.73	9.32	9.92	10.44
55	7.11	7.68	8.22	9.30	10.18	10.85	11.59	12.34	12.98
54	7.95	8.59	9.23	10.45	11.39	12.25	13.08	13.93	14.65
53	9.30	10.04	10.80	12.20	13.32	14.29	15.27	16.25	17.09
52	10.61	11.46	12.31	13.86	15.26	16.34	17.44	18.57	19.53
51	11.82	12.77	13.69	15.47	16.97	18.16	19.40	20.64	21.71
50	12.89	13.92	14.94	16.86	18.48	19.77	21.12	22.48	23.65
49	14.07	15.20	16.28	18.37	20.20	21.60	23.06	24.56	25.83
48	15.15	16.36	17.62	19.88	21.81	23.31	24.90	26.51	27.89
47	16.22	17.52	18.80	21.27	23.21	24.93	26.62	28.34	29.81
46	17.19	18.57	19.98	22.57	24.72	26.43	28.23	30.05	31.61

Table F-1 (Continued)

Orifice or Drill Size	Pressure at Orifice—Inches Water Column								
	3	3.5	4	5	6	7	8	9	10
45	17.73	19.15	20.52	23.10	25.36	27.18	29.03	30.90	32.51
44	19.45	21.01	22.57	25.57	27.93	29.87	31.89	33.96	35.72
43	20.73	22.39	24.18	27.29	29.87	32.02	34.19	36.41	38.30
42	23.10	24.95	26.50	29.50	32.50	35.24	37.63	40.07	42.14
41	24.06	25.98	28.15	31.69	34.81	37.17	39.70	42.27	44.46
40	25.03	27.03	29.23	33.09	36.20	38.79	41.42	44.10	46.38
39	26.11	28.20	30.20	34.05	37.38	39.97	42.68	45.44	47.80
38	27.08	29.25	31.38	35.46	38.89	41.58	44.40	47.27	49.73
37	28.36	30.63	32.99	37.07	40.83	43.62	46.59	49.60	52.17
36	29.76	32.14	34.59	39.11	42.76	45.77	48.88	52.04	54.74
35	32.36	34.95	36.86	41.68	45.66	48.78	52.10	55.46	58.34
34	32.45	35.05	37.50	42.44	46.52	49.75	53.12	56.55	59.49
33	33.41	36.08	38.79	43.83	48.03	51.46	54.96	58.62	61.55
32	35.46	38.30	40.94	46.52	50.82	54.26	57.95	61.70	64.89
31	37.82	40.85	43.83	49.64	54.36	58.01	61.96	65.97	69.39
30	43.40	46.87	50.39	57.05	62.09	66.72	71.22	75.86	79.80
29	48.45	52.33	56.19	63.61	69.62	74.45	79.52	84.66	89.04
28	51.78	55.92	59.50	67.00	73.50	79.50	84.92	90.39	95.09
27	54.47	58.83	63.17	71.55	78.32	83.59	89.27	95.04	99.97
26	56.73	61.27	65.86	74.57	81.65	87.24	93.17	99.19	104.57
25	58.87	63.58	68.22	77.14	84.67	90.36	96.50	102.74	108.07
24	60.81	65.67	70.58	79.83	87.56	93.47	99.83	106.28	111.79
23	62.10	67.07	72.20	81.65	89.39	94.55	100.98	107.49	113.07
22	64.89	70.08	75.21	85.10	93.25	99.60	106.39	113.24	119.12
21	66.51	71.83	77.14	87.35	95.63	102.29	109.24	116.29	122.33
20	68.22	73.68	79.08	89.49	97.99	104.75	111.87	119.10	125.28
19	72.20	77.98	83.69	94.76	103.89	110.67	118.55	125.82	132.36
18	75.53	81.57	87.56	97.50	108.52	116.03	123.92	131.93	138.78
17	78.54	84.82	91.10	103.14	112.81	120.33	128.52	136.82	143.91
16	82.19	88.77	95.40	107.98	118.18	126.78	135.39	144.15	151.63
15	85.20	92.02	98.84	111.74	122.48	131.07	139.98	149.03	156.77
14	87.10	94.40	100.78	114.21	124.44	133.22	142.28	151.47	159.33
13	89.92	97.11	104.32	118.18	128.93	138.60	148.02	157.58	165.76
12	93.90	101.41	108.52	123.56	135.37	143.97	153.75	163.69	172.13
11	95.94	103.62	111.31	126.02	137.52	147.20	157.20	167.36	176.03
10	98.30	106.16	114.21	129.25	141.82	151.50	161.81	172.26	181.13
9	100.99	109.07	117.11	132.58	145.05	154.71	165.23	175.91	185.03
8	103.89	112.20	120.65	136.44	149.33	160.08	170.96	182.00	191.44
7	105.93	114.40	123.01	139.23	152.56	163.31	174.38	185.68	195.30
6	109.15	117.88	126.78	142.88	156.83	167.51	178.88	190.46	200.36
5	111.08	119.97	128.93	145.79	160.08	170.82	182.48	194.22	204.30
4	114.75	123.93	133.22	150.41	164.36	176.18	188.16	200.25	210.71
3	119.25	128.79	137.52	156.26	170.78	182.64	195.08	207.66	218.44
2	128.48	138.76	148.61	168.64	184.79	197.66	211.05	224.74	235.58
1	136.35	147.26	158.25	179.33	194.63	209.48	223.65	238.16	250.54

Table F-2

LP-Gases
(Btu per hour at sea level)

	Propane	Butane
Btu per Cubic Foot =	2,516	3,280
Specific Gravity =	1.52	2.01
Pressure at Orifice, Inches Water Column =	11	11
Orifice Coefficient =	0.9	0.9

For altitudes above 2,000 feet, first select the equivalent orifice size at sea level from Table F-4.

Orifice or Drill Size	Propane	Butane
.008	519	589
.009	656	744
.010	812	921
.011	981	1,112
.012	1,169	1,326
80	1,480	1,678
79	1,708	1,936
78	2,080	2,358
77	2,629	2,980
76	3,249	3,684
75	3,581	4,059
74	4,119	4,669
73	4,678	5,303
72	5,081	5,760
71	5,495	6,230
70	6,375	7,227
69	6,934	7,860
68	7,813	8,858
67	8,320	9,433
66	8,848	10,031
65	9,955	11,286
64	10,535	11,943
63	11,125	12,612
62	11,735	13,304
61	12,367	14,020
60	13,008	14,747
59	13,660	15,486
58	14,333	16,249
57	15,026	17,035
56	17,572	19,921
55	21,939	24,872
54	24,630	27,922
53	28,769	32,615
52	32,805	37,190
51	36,531	41,414
50	39,842	45,168

Table F-2 (Continued)

Orifice or Drill Size	Propane	Butane
49	43,361	49,157
48	46,983	53,263
47	50,088	56,783
46	53,296	60,420
45	54,641	61,944
44	60,229	68,280
43	64,369	72,973
42	71,095	80,599
41	74,924	84,940
40	78,029	88,459
39	80,513	91,215
38	83,721	94,912
37	87,860	99,605
36	92,207	104,532
35	98,312	111,454
34	100,175	113,566
33	103,797	117,672
32	109,385	124,007
31	117,043	132,689
30	134,119	152,046
29	150,366	170,466
28	160,301	181,728
27	168,580	191,114
26	175,617	199,092
25	181,619	205,896
24	187,828	212,935
23	192,796	218,567
22	200,350	227,131
21	205,525	232,997
20	210,699	238,863
19	223,945	253,880
18	233,466	264,673

Table F-3

Multipliers for Utility Gases of Another Specific Gravity

Specific Gravity	Multiplier	Specific Gravity	Multiplier
0.45	1.155	0.95	0.795
0.50	1.095	1.00	0.775
0.55	1.045	1.05	0.756
0.60	1.000	1.10	0.739
0.65	0.961	1.15	0.722
0.70	0.926	1.20	0.707
0.75	0.894	1.25	0.693
0.80	0.866	1.30	0.679
0.85	0.840	1.35	0.667
0.90	0.817	1.40	0.655

Table F-4

Equivalent Orifice Sizes at High Altitudes
(Includes 4% input reduction for each 1,000 feet)

Orifice Size at Sea Level	Orifice Size Required at Other Elevations								
	2000	3000	4000	5000	6000	7000	8000	9000	10000
1	2	2	3	3	4	5	7	8	10
2	3	3	4	5	6	7	9	10	12
3	4	5	7	8	9	10	12	13	15
4	6	7	8	9	11	12	13	14	16
5	7	8	9	10	12	13	14	15	17
6	8	9	10	11	12	13	14	16	17
7	9	10	11	12	13	14	15	16	18
8	10	11	12	13	13	15	16	17	18
9	11	12	12	13	14	16	17	18	19
10	12	13	13	14	15	16	17	18	19
11	13	13	14	15	16	17	18	19	20
12	13	14	15	16	17	17	18	19	20
13	15	15	16	17	18	18	19	20	22
14	16	16	17	18	18	19	20	21	23
15	16	17	17	18	19	20	20	22	24
16	17	18	18	19	19	20	22	23	25
17	18	19	19	20	21	22	23	24	26
18	19	19	20	21	22	23	24	26	27
19	20	20	21	22	23	25	26	27	28
20	22	22	23	24	25	26	27	28	29
21	23	23	24	25	26	27	28	28	29
22	23	24	25	26	27	27	28	29	29
23	25	25	26	27	27	28	29	29	30
24	25	26	27	27	28	28	29	29	30
25	26	27	27	28	28	29	29	30	30
26	27	28	28	28	29	29	30	30	30
27	28	28	29	29	29	30	30	30	31
28	29	29	29	30	30	30	30	31	31
29	29	30	30	30	30	31	31	31	32
30	30	31	31	31	31	32	32	33	35
31	32	32	32	33	34	35	36	37	38
32	33	34	35	35	36	36	37	38	40
33	35	35	36	36	37	38	38	40	41
34	35	36	36	37	37	38	39	40	42
35	36	36	37	37	38	39	40	41	42
36	37	38	38	39	40	41	41	42	43
37	38	39	39	40	41	42	42	43	43
38	39	40	41	41	42	42	43	43	44
39	40	41	41	42	42	43	43	44	44
40	41	42	42	42	43	43	44	44	45
41	42	42	42	43	43	44	44	45	46
42	42	43	43	43	44	44	45	46	47
43	44	44	44	45	45	46	47	47	48
44	45	45	45	46	47	47	48	48	49
45	46	47	47	47	48	48	49	49	50
46	47	47	47	48	48	49	49	50	50

Table F-4 (Continued)

Orifice Size at Sea Level	Orifice Size Required at Other Elevations								
	2000	3000	4000	5000	6000	7000	8000	9000	10000
47	48	48	49	49	49	50	50	51	51
48	49	49	49	50	50	50	51	51	52
49	50	50	50	51	51	51	52	52	52
50	51	51	51	51	52	52	52	53	53
51	51	52	52	52	52	53	53	53	54
52	52	53	53	53	53	53	54	54	54
53	54	54	54	54	54	54	55	55	55
54	54	55	55	55	55	55	56	56	56
55	55	55	55	56	56	56	56	56	57
56	56	56	57	57	57	58	59	59	60
57	58	59	59	60	60	61	62	63	63
58	59	60	60	61	62	62	63	63	64
59	60	61	61	62	62	63	64	64	65
60	61	61	62	63	63	64	64	65	65
61	62	62	63	63	64	65	65	66	66
62	63	63	64	64	65	65	66	66	67
63	64	64	65	65	65	66	66	67	68
64	65	65	65	66	66	66	67	67	68
65	65	66	66	66	67	67	68	68	69
66	67	67	68	68	68	69	69	69	70
67	68	68	68	69	69	69	70	70	70
68	68	69	69	69	70	70	70	71	71
69	70	70	70	70	71	71	71	72	72
70	70	71	71	71	71	72	72	73	73
71	72	72	72	73	73	73	74	74	74
72	73	73	73	73	74	74	74	74	75
73	73	74	74	74	74	75	75	75	76
74	74	75	75	75	75	76	76	76	76
75	75	76	76	76	76	77	77	77	77
76	76	76	77	77	77	77	77	77	77
77	77	77	77	78	78	78	78	78	78
78	78	78	78	79	79	79	79	80	80
79	79	80	80	80	80	.013	.012	.012	.012
80	80	.013	.013	.013	.012	.012	.012	.012	.011

Use of Orifice Tables

A. To Check Burner Input in Accordance with 8.1.3(b):

Gage size of burner orifice and determine flow rate at sea level from Table F-1 — Utility Gases (cubic feet hour), or from Table F-2 — LP-Gases (Btu per hour). When the specific gravity of the utility gas is other than 0.6, select the multiplier from Table F-3 for the specific gravity of the utility gas served and apply to the flow rate as determined from Table F-1. When altitude is above 2,000 feet, first select equivalent orifice size at sea level using Table F-4 and then determine flow rate from Table F-1 or Table F-2 as directed above.

Having determined flow rate (as adjusted for specific gravity and/or altitude when necessary), check the burner input at sea level with the manufacturer's rated input.

B. To Select Correct Orifice Size for Rated Burner Input:

The selection of a fixed orifice size for any rated burner input is affected by many variables, including orifice coefficient, and it is recommended that the appliance manufacturer be consulted for that purpose. When correct orifice size cannot be readily determined, the orifice flow rates, as stated in the tables in this appendix, may be used to select a fixed orifice size with a flow rate to approximately equal the required rated burner input.

For gases of the specific gravity and pressure conditions stipulated at elevations under 2,000 feet, Table F-1 (in cubic feet per hour) or Table F-2 (in Btu per hour) may be used directly.

When the specific gravity of the gas is other than 0.6, select the multiplier from Table F-3 for the utility gas served and divide the rated burner input by the selected factor to determine equivalent input at a specific gravity of 0.60 and then select orifice size as directed above.

When the appliance is located at an altitude of 2,000 feet or above, first use the manufacturer's rated input at sea level to select orifice size as directed above, then use Table F-4 to select the equivalent orifice size for use at the higher altitude.

APPENDIX G

SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS AND APPLIANCES LISTED FOR USE WITH TYPE B VENTS

(This Appendix is informative and is not a part of the Code.)

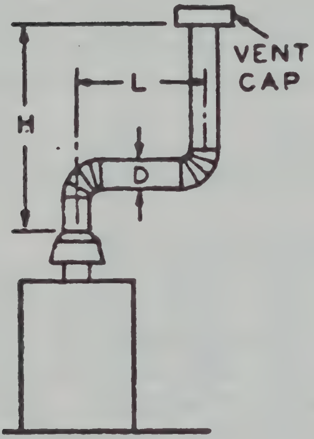

Figure G-1
Double Wall or Asbestos Cement Type B Vents or Single-Wall Metal Vents Serving a Single Appliance. (See Tables G-1 and G-2.)

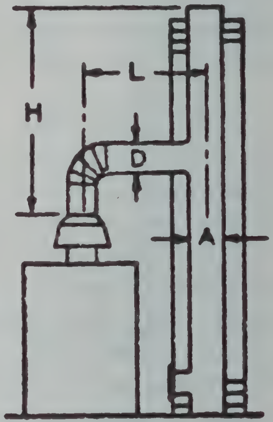

Figure G-2
Masonry Chimney Serving a Single Appliance. (See Table G-3.)

Notes for Single Appliance Vents. (See Tables G-1, G-2 and G-3.)

1. For single-wall metal pipe, use Table G-2.
2. If the vent size determined from the Tables is less than the size of the draft hood, the smaller sized vent may be used as long as the vent height "H" is at least 10 feet.
3. Vents for draft hoods 12 inches in diameter or less should not be reduced more than one size (12 inches to 10 inches is a one-size reduction). For larger fuel-gas burning equipment, reductions of more than two sizes (24 inches to 20 inches is a two-size reduction) are not recommended.
4. Regardless of the vent size shown, do not connect any 4-inch draft hoods to 3-inch vents.
5. Zero (0) lateral "L" applies only to a straight vertical vent attached to a top outlet draft hood.
6. Use sea level input rating when calculating vent size for high altitude installation.
7. Designation "NR" in Tables G-1, G-2 and G-3 indicates not recommended.
8. Number followed by an asterisk (*) in Tables G-2 and G-3 indicate the possibility of continuous condensation, depending on locality. Consult local serving gas supplier and/or local codes.

Table G-1

Capacity of Type B Double-Wall Vents with Type B Double-Wall Connectors Serving a Single Appliance

Height H	Lateral L	Vent Diameter — D													
		3″	4″	5″	6″	7″	8″	10″	12″	14″	16″	18″	20″	22″	24″
		Maximum Appliance Input Rating in Thousands of Btu Per Hour													
6′	0	46	86	141	205	285	370	570	850	1170	1530	1960	2430	2950	3520
	2′	36	67	105	157	217	285	455	650	890	1170	1480	1850	2220	2670
	6′	32	61	100	149	205	273	435	630	870	1150	1470	1820	2210	2650
	12′	28	55	91	137	190	255	406	610	840	1110	1430	1795	2180	2600
8′	0	50	94	155	235	320	415	660	970	1320	1740	2220	2750	3360	4010
	2′	40	75	120	180	247	322	515	745	1020	1340	1700	2110	2560	3050
	8′	35	66	109	165	227	303	490	720	1000	1320	1670	2070	2530	3030
	16′	28	58	96	148	206	281	458	685	950	1260	1600	2035	2470	2960
10′	0	53	100	166	255	345	450	720	1060	1450	1925	2450	3050	3710	4450
	2′	42	81	129	195	273	355	560	850	1130	1480	1890	2340	2840	3390
	10′	36	70	115	175	245	330	525	795	1080	1430	1840	2280	2780	3340
	20′	NR	60	100	154	217	300	486	735	1030	1360	1780	2230	2720	3250
15′	0	58	112	187	285	390	525	840	1240	1720	2270	2900	3620	4410	5300
	2′	48	93	150	225	316	414	675	985	1350	1770	2260	2800	3410	4080
	15′	37	76	128	198	275	373	610	905	1250	1675	2150	2700	3300	3980
	30′	NR	60	107	169	243	328	553	845	1160	1550	2050	2620	3210	3840
20′	0	61	119	202	307	430	575	930	1350	1900	2520	3250	4060	4980	6000
	2′	51	100	166	249	346	470	755	1100	1520	2000	2570	3200	3910	4700
	10′	44	89	150	228	321	443	710	1045	1460	1940	2500	3130	3830	4600
	20′	35	78	134	206	295	410	665	990	1390	1880	2430	3050	3760	4550
	30′	NR	68	120	186	273	380	626	945	1270	1700	2330	2980	3650	4390

Table G-1 (Continued)

Height H	Lateral L	Vent Diameter — D													
		3″	4″	5″	6″	7″	8″	10″	12″	14″	16″	18″	20″	22″	24″
		Maximum Appliance Input Rating in Thousands of Btu Per Hour													
30′	0	64	128	220	336	475	650	1060	1550	2170	2920	3770	4750	5850	7060
	2′	56	112	185	280	394	535	865	1310	1800	2380	3050	3810	4650	5600
	20′	NR	90	154	237	343	473	784	1185	1650	2200	2870	3650	4480	5310
	40′	NR	NR	NR	200	298	415	705	1075	1520	2060	2700	3480	4270	5140
40′	0	66	132	228	353	500	685	1140	1730	2400	3230	4180	5270	6500	7860
	2′	59	118	198	298	420	579	960	1420	2000	2660	3420	4300	5260	6320
	20′	NR	96	167	261	377	516	860	1310	1830	2460	3200	4050	5000	6070
	40′	NR	NR	NR	223	333	460	785	1205	1710	2310	3020	3840	4780	5820
60′	0	NR	136	236	373	535	730	1250	1920	2700	3650	4740	6000	7380	9000
	2′	NR	125	213	330	470	650	1060	1605	2250	3020	3920	4960	6130	7400
	30′	NR	NR	170	275	397	555	930	1440	2050	2780	3640	4700	5730	7000
	60′	NR	NR	NR	NR	334	475	830	1285	1870	2560	3380	4330	5420	6600
80′	0	NR	NR	239	384	550	755	1290	2020	2880	3900	5100	6450	8000	9750
	2′	NR	NR	217	350	495	683	1145	1740	2460	3320	4310	5450	6740	8200
	40′	NR	NR	NR	275	404	570	980	1515	2180	2980	3920	5000	6270	7650
	80′	NR	NR	NR	NR	NR	NR	850	1420	2000	2750	3640	4680	5850	7200
100′	0	NR	NR	NR	400	560	770	1310	2050	2950	4050	5300	6700	8600	10300
	2′	NR	NR	NR	375	510	700	1170	1820	2550	3500	4600	5800	7200	8800
	50′	NR	NR	NR	NR	405	575	1000	1550	2250	3100	4050	5300	6600	8100
	100′	NR	NR	NR	NR	NR	NR	870	1430	2050	2850	3750	4900	6100	7500

See Figure G-1 and Notes for Single Appliance Vents.

Table G-2

Capacity of Single-Wall Metal Pipe or Type B Asbestos Cement Vents Serving a Single Appliance

Height H	Lateral L	Vent Diameter — D							
		3"	4"	5"	6"	7"	8"	10"	12"
		Maximum Appliance Input Rating in Thousands of Btu Per Hour							
6'	0	39	70	116	170	232	312	500	750
	2'	31	55	94	141	194	260	415	620
	5'	28	51	88	128	177	242	390	600
8'	0	42	76	126	185	252	340	542	815
	2'	32	61	102	154	210	284	451	680
	5'	29	56	95	141	194	264	430	548
	10'	24*	49	86	131	180	250	406	625
10'	0	45	84	138	202	279	372	606	912
	2'	35	67	111	168	233	311	505	760
	5'	32	61	104	153	215	289	480	724
	10'	27*	54	94	143	200	274	455	700
	15'	NR	46*	84	130	186	258	432	666
15'	0	49	91	151	223	312	420	684	1040
	2'	39	72	122	186	260	350	570	865
	5'	35*	67	110	170	240	325	540	825
	10'	30*	58*	103	158	223	308	514	795
	15'	NR	50*	93*	144	207	291	488	760
	20'	NR	NR	82*	132*	195	273	466	726
20'	0	53*	101	163	252	342	470	770	1190
	2'	42*	80	136	210	286	392	641	990
	5'	38*	74*	123	192	264	364	610	945
	10'	32*	65*	115*	178	246	345	571	910
	15'	NR	55*	104*	163	228	326	550	870
	20'	NR	NR	91*	149*	214*	306	525	832
30'	0	56*	108*	183	276	384	529	878	1370
	2'	44*	84*	148*	230	320	441	730	1140
	5'	NR	78*	137*	210	296	410	694	1080
	10'	NR	68*	125*	196*	274	388	656	1050
	15'	NR	NR	113*	177*	258*	366	625	1000
	20'	NR	NR	99*	163*	240*	344	596	960
	30'	NR	NR	NR	NR	192*	295*	540	890
50'	0	NR	120*	210*	310*	443*	590	980	1550
	2'	NR	95*	171*	260*	370*	492	820	1290
	5'	NR	NR	159*	234*	342*	474	780	1230
	10'	NR	NR	146*	221*	318*	456*	730	1190
	15'	NR	NR	NR	200*	292*	407*	705	1130
	20'	NR	NR	NR	185*	276*	384*	670*	1080
	30'	NR	NR	NR	NR	222*	330*	605*	1010

See Figure G-2 and Notes for Single Appliance Vents.

Table G-3

Capacity of Masonry Chimneys and Single-Wall Vent Connectors Serving a Single Appliance

Height H	Lateral L	Single-Wall Vent Connector Diameter — D							
		To be used with chimney areas not less than those at bottom							
		3″	4″	5″	6″	7″	8″	10″	12″
		Maximum Appliance Input Rating in Thousands of Btu Per Hour							
6′	2′	28	52	86	130	180	247	400	580
	5′	25*	48	81	118	164	230	375	560
8′	2′	29	55	93	145	197	265	445	650
	5′	26*	51	87	133	182	246	422	638
	10′	22*	44*	79	123	169	233	400	598
10′	2′	31	61	102	161	220	297	490	722
	5′	28*	56	95	147	203	276	465	710
	10′	24*	49*	86	137	189	261	441	665
	15′	NR	42*	79*	125	175	246	421	634
15′	2′	35*	67	113	178	249	335	560	840
	5′	32*	61	106	163	230	312	531	825
	10′	27*	54*	96	151	214	294	504	774
	15′	NR	46*	87*	138	198	278	481	738
	20′	NR	NR	73*	128*	184	261	459	706
20′	2′	38*	73	123	200	273	374	625	950
	5′	35*	67*	115	183	252	348	594	930
	10′	NR	59*	105*	170	235	330	562	875
	15′	NR	NR	95*	156	217	311	536	835
	20′	NR	NR	80*	144*	202	292	510	800
30′	2′	41*	81*	136	215	302	420	715	1110
	5′	NR	75*	127*	196	279	391	680	1090
	10′	NR	66*	113*	182*	260	370	644	1020
	15′	NR	NR	105*	168*	240*	349	615	975
	20′	NR	NR	88*	155*	223*	327	585	932
	30′	NR	NR	NR	NR	182*	281*	544	865
50′	2′	NR	91*	160*	250*	350*	475	810	1240
	5′	NR	NR	149*	228*	321*	442	770	1220
	10′	NR	NR	136*	212*	301*	420*	728	1140
	15′	NR	NR	124*	195*	278*	395*	695	1090
	20′	NR	NR	NR	180*	258*	370*	660*	1040
	30′	NR	NR	NR	NR	NR	318*	610*	970
Minimum Internal Area of Chimney-A Square Inches		19		28	38	50	63	95	132

See Table G-7 for Masonry Chimney Liner Sizes
See Figure G-2 and Notes for Single Appliance Vents.

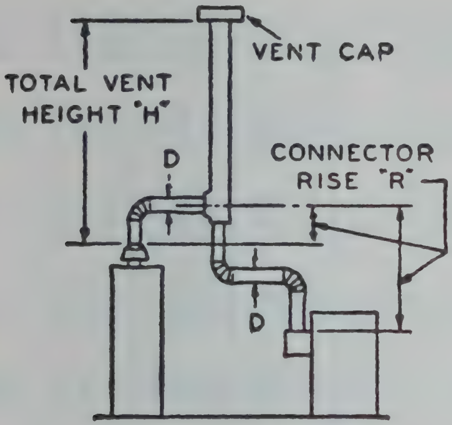

Figure G-3
Double-Wall or Asbestos Cement Type B Vents or Single-Wall Metal Vents Serving Two or More Appliances. (See Tables G-4 and G-5.)

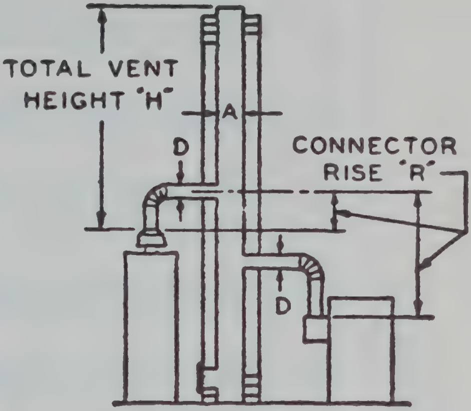

Figure G-4
Masonry Chimney Serving Two or More Appliances. (See Table G-6.)

Notes for Multiple Appliance Vents. (See Tables G-4, G-5 and G-6.)

1. For single-wall metal pipe connectors, use Table G-5.
2. Maximum Vent Connector Length: 1½ feet for every inch of connector diameter. Greater lengths require increase in size, rise or total vent height, to obtain full capacity.
3. Each 90-degree turn in excess of the first two reduces the connector capacity by 10 percent.
4. Each 90-degree turn in the common vent reduces capacity by 10 percent.
5. Where possible, locate vent closer to or directly over smaller appliance connector.
6. Connectors must be equal to or larger than draft hood outlets.
7. If both connectors are same size, common vent must be at least one size larger, regardless of tabulated capacity.
8. Common vent must be equal to or larger than largest connector.
9. Interconnection fittings must be same size as common vent.
10. Use sea level input rating when calculating vent size for high altitude installation.
11. Designation "NR" in Tables G-4, G-5 and G-6 indicates not recommended.

Table G-4

Capacity of Type B Double-Wall Vents with Type B Double-Wall Connectors Serving Two or More Appliances

Vent Connector Capacity

Total Vent Height "H"	Connector Rise "R"	Vent Connector Diameter — D													
		3"	4"	5"	6"	7"	8"	10"	12"	14"	16"	18"	20"	22"	24"
		Maximum Appliance Input Rating in Thousands of Btu Per Hour													
6'	1'	26	46	72	104	142	185	289	416	577	755	955	1180	1425	1700
	2'	31	55	86	124	168	220	345	496	653	853	1080	1335	1610	1920
	3'	35	62	96	139	189	248	386	556	740	967	1225	1510	1830	2180
8'	1'	27	48	76	109	148	194	303	439	601	805	1015	1255	1520	1810
	2'	32	57	90	129	175	230	358	516	696	910	1150	1420	1720	2050
	3'	36	64	101	145	198	258	402	580	790	1030	1305	1610	1950	2320
10'	1'	28	50	78	113	154	200	314	452	642	840	1060	1310	1585	1890
	2'	33	59	93	134	182	238	372	536	730	955	1205	1490	1800	2150
	3'	37	67	104	150	205	268	417	600	827	1080	1370	1690	2040	2430
15'	1'	30	53	83	120	163	214	333	480	697	910	1150	1420	1720	2050
	2'	35	63	99	142	193	253	394	568	790	1030	1305	1610	1950	2320
	3'	40	71	111	160	218	286	444	640	898	1175	1485	1835	2220	2640
20'	1'	31	56	87	125	171	224	347	500	740	965	1225	1510	1830	2190
	2'	37	66	104	149	202	265	414	596	840	1095	1385	1710	2070	2470
	3'	42	74	116	168	228	300	466	672	952	1245	1575	1945	2350	2800
30'	1'	33	59	93	134	182	238	372	536	805	1050	1330	1645	1990	2370
	2'	39	70	110	158	215	282	439	632	910	1190	1500	1855	2240	2670
	3'	44	79	124	178	242	317	494	712	1035	1350	1710	2110	2550	3040
40'	1'	35	62	97	140	190	248	389	560	850	1110	1405	1735	2100	2500
	2'	41	73	115	166	225	295	461	665	964	1260	1590	1965	2380	2830
	3'	46	83	129	187	253	331	520	748	1100	1435	1820	2240	2710	3230
60' to 100'	1'	37	66	104	150	204	266	417	600	926	1210	1530	1890	2280	2720
	2'	44	79	123	178	242	316	494	712	1050	1370	1740	2150	2590	3090
	3'	50	89	138	200	272	355	555	800	1198	1565	1980	2450	2960	3520

Table G-4 (Continued)

Common Vent Capacity

Total Vent Height "H"	Common Vent Diameter													
	3"	4"	5"	6"	7"	8"	10"	12"	14"	16"	18"	20"	22"	24"
	Combined Appliance Input Rating in Thousands of Btu Per Hour													
6'	—	65	103	147	200	260	410	588	815	1065	1345	1660	1970	2390
8'	—	73	114	163	223	290	465	652	912	1190	1510	1860	2200	2680
10'	—	79	124	178	242	315	495	712	995	1300	1645	2030	2400	2920
15'	—	91	144	206	280	365	565	825	1158	1510	1910	2360	2790	3400
20'	—	102	160	229	310	405	640	916	1290	1690	2140	2640	3120	3800
30'	—	118	185	266	360	470	740	1025	1525	1990	2520	3110	3680	4480
40'	—	131	203	295	405	525	820	1180	1715	2240	2830	3500	4150	5050
60'	—	NR	224	324	440	575	900	1380	2010	2620	3320	4100	4850	5900
80'	—	NR	NR	344	468	610	955	1540	2250	2930	3710	4590	5420	6600
100'	—	NR	NR	NR	479	625	975	1670	2450	3200	4050	5000	5920	7200

See Figure G-3 and Notes for Multiple Appliance Vents.

Example of Multiple Vent Design Using Table G-4 Double-Wall Type B Vent

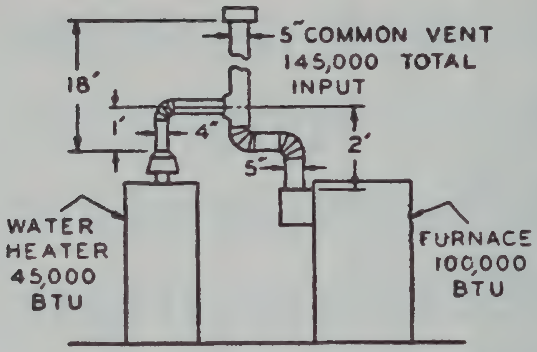

Figure G-5 Example: Connect a 45,000 Btu water heater with a 1-foot connector rise "R" and a 100,000 Btu furnace with a 2-foot connector rise "R" to a common vent with a minimum total vent height "H" of 18 feet.

1. WATER HEATER VENT CONNECTOR SIZE. Using Table G-4, read down Total Vent Height "H" column to 15 feet and read across 1-foot Connector Rise "R" line to Btu rating equal to or higher than water heater input rating. This figure shows 53,000 Btu and is in the column for 4-inch connector. Since this is in excess of the water heater input it is not necessary to find the maximum input for an 18-foot minimum total vent height. Use a 4-inch connector.

2. FURNACE VENT CONNECTOR SIZE. Under Vent Connector Tables read down Total Vent Height "H" column to 15-foot and read across 2-foot Connector Rise "R" line. Note 5-inch vent size shows 99,000 Btu per hour or less than furnace input. However, with 20-foot Total Height read across 2-foot connector rise line. Note 5-inch vent size shows 104,000 Btu per hour. Since 18-foot height is ⅗ of difference between 15- and 20-foot heights, take difference between 99,000 and 104,000 or 5,000 and add ⅗ of this to 15-foot figure of 99,000, 99,000 + 3,000 = 102,000 which is maximum input for 18-foot Total Vent Height. Therefore a 5-inch connector would be the correct size for the furnace, providing the furnace had a 5-inch or smaller draft hood outlet.

3. COMMON VENT SIZE. Total input to Common Vent is 145,000 Btu. Note that for 15-foot Total Vent Height "H" maximum Btu for 5-inch vent is 144,000. For 20-foot Total Vent Height "H" maximum Btu for 5-inch vent is 160,000.

Therefore for 18-foot Total Vent Height maximum allowable input would be ⅗ of difference between 144,000 and 160,000 = ⅗ x 16,000 or 9,600; 144,000 + 9,600 = 153,600 which is greater than total input to common vent. Therefore common vent can be 5-inch-diameter pipe.

Table G-5

Capacity of a Single-Wall Metal Pipe or Type B Asbestos Cement Vent Serving Two or More Appliances

Vent Connector Capacity

Total Vent Height "H"	Connector Rise "R"	Vent Connector Diameter—D 3"	4"	5"	6"	7"	8"
		Maximum Appliance Input Rating in Thousands of Btu Per Hour					
6'-8'	1'	21	40	68	102	146	205
	2'	28	53	86	124	178	235
	3'	34	61	98	147	204	275
15'	1'	23	44	77	117	179	240
	2'	30	56	92	134	194	265
	3'	35	64	102	155	216	298
30' and up	1'	25	49	84	129	190	270
	2'	31	58	97	145	211	295
	3'	36	68	107	164	232	321

Common Vent Capacity

Total Vent Height "H"	Common Vent Diameter 4"	5"	6"	7"	8"	10"	12"
	Combined Appliance Input Rating in Thousands of Btu Per Hour						
6'	48	78	111	155	205	320	NR
8'	55	89	128	175	234	365	505
10'	59	95	136	190	250	395	560
15'	71	115	168	228	305	480	690
20'	80	129	186	260	340	550	790
30'	NR	147	215	300	400	650	940
50'	NR	NR	NR	360	490	810	1190

See Figure G-3 and Notes for Multiple Appliance Vents.

Table G-6

Capacity of a Masonry Chimney and Single-Wall Vent Connectors Serving Two or More Appliances

Single-Wall Vent Connector Capacity

Total Vent Height "H"	Rise Connector "R"	Vent Connector Diameter—D					
		3"	4"	5"	6"	7"	8"
		Maximum Appliance Input Rating in Thousands of Btu Per Hour					
6'-8'	1'	21	39	66	100	140	200
	2'	28	52	84	123	172	231
	3'	34	61	97	142	202	269
15'	1'	23	43	73	112	171	225
	2'	30	54	88	132	189	256
	3'	34	63	101	151	213	289
30' and up	1'	24	47	80	124	183	250
	2'	31	57	93	142	205	282
	3'	35	65	105	160	229	312

Common Chimney Capacity

Total Vent Height "H"	Minimum Internal Area of Chimney—"A" Square Inches					
	19	28	38	50	78	113
	Combined Appliance Input Rating in Thousands of Btu Per Hour					
6'	45	71	102	142	245	NR
8'	52	81	118	162	277	405
10'	56	89	129	175	300	450
15'	66	105	150	210	360	540
20'	74	120	170	240	415	640
30'	NR	135	195	275	490	740
50'	NR	NR	NR	325	600	910

See Table G-7 for Masonry Chimney Liner Sizes.
See Figure G-4 and Notes for Multiple Appliance Vents.

Table G-7

Masonry Chimney Liner Dimensions with Circular Equivalents

Nominal Liner Size Inches	Inside Dimensions of Liner in Inches	Inside Diameter or Equivalent Diameter Inches	Equivalent Area Square Inches
4 x 8	2½ x 6½	4	12.2
		5	19.6
		6	28.3
		7	38.3
8 x 8	6¾ x 6¾	7.4	42.7
		8	50.3
8 x 12	6½ x 10½	9	63.6
		10	78.5
12 x 12	9¾ x 9¾	10.4	83.3
		11	95
12 x 16	9½ x 13½	11.8	107.5
		12	113.0
		14	153.9
16 x 16	13¼ x 13¼	14.5	162.9
		15	176.7
16 x 20	13 x 17	16.2	206.1
		18	254.4
20 x 20	16¾ x 16¾	18.2	260.2
		20	314.1
20 x 24	16½ x 20½	20.1	314.2
		22	380.1
24 x 24	20¼ x 20¼	22.1	380.1
		24	452.3
24 x 28	20¼ x 24¼	24.1	456.2
28 x 28	24¼ x 24¼	26.4	543.3
		27	572.5
30 x 30	25½ x 25½	27.9	607
		30	706.8
30 x 36	25½ x 31½	30.9	749.9
		33	855.3
36 x 36	31½ x 31½	34.4	929.4
		36	1017.9

When liner sizes differ dimensionally from those shown in Table G-7, equivalent diameters may be determined from published tables for square and rectangular ducts of equivalent carrying capacity or by other engineering methods.

APPENDIX H

RECOMMENDED PROCEDURE FOR SAFETY INSPECTION OF AN EXISTING APPLIANCE INSTALLATION

(This Appendix is informative and is not a part of the Code.)

The following procedure is intended as a guide to aid in determining that an appliance is properly installed and is in a safe condition for continuing use.

This procedure is predicated on central furnace and boiler installations, and it should be recognized that generalized procedures cannot anticipate all situations. Accordingly, in some cases deviation from this procedure may be necessary to determine safe operation of the equipment:

a. This procedure should be performed prior to any attempt at modification of the appliance or of the installation.

b. If it is determined there is a condition which could result in unsafe operation, the appliance should be shut off and the owner advised of the unsafe condition.

The following steps should be followed in making the safety inspection:

1. Conduct a gas leakage test of the appliance piping and control system downstream of the shutoff valve in the supply line to the appliance. (See 5.5.4.)
2. Visually inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion, and other deficiencies which could cause an unsafe condition.
3. Shut off all gas to the appliance and shut off any other fuel-gas burning appliance within the same room. Use the shutoff valve in the supply line to each appliance.
4. Inspect burners and crossovers for blockage and corrosion.
5. Applicable only to furnaces. Inspect heat exchanger for cracks, openings, or excessive corrosion.
6. Applicable only to boilers. Inspect for evidence of water or combustion product leaks.
7. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliance is located and other spaces of the building. Turn on clothes dryers. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so

they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers. If, after completing Steps 8 through 13, it is believed sufficient combustion air is not available, refer to 5.3 of this Code for guidance.

8. Place in operation the appliance being inspected. Follow the lighting instructions. Adjust thermostat so appliance will operate continuously.

9. Determine that the pilot(s) is burning properly and that main burner ignition is satisfactory by interrupting and reestablishing the electrical supply to the appliance in any convenient manner. Test the pilot safety device to determine it is operating properly by extinguishing the pilot burner(s) when the main burner(s) is off and determining, after 3 minutes, that the main burner gas does not flow upon a call for heat.

10. (a) Visually determine that main burner gas is burning properly: i.e., no floating, lifting or flashback. Adjust the primary air shutter(s) as required.
    (b) If appliance is equipped with high and low flame controlling or flame modulation, check for proper main burner operation at low flame.

11. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use a draft gage, flame of a match or candle, or smoke from a cigarette, cigar, or pipe.

12. Turn on all other fuel-gas burning appliances within the same room so they will operate at their full inputs. Follow lighting instructions for each appliance.

13. Repeat Steps 10 and 11 on the appliance being inspected.

14. Return doors, windows, exhaust fans, fireplace dampers, and any other fuel-gas burning appliance to their previous conditions of use.

15. **Applicable only to furnaces.** Check both the limit control and the fan control for proper operation. Limit control operation can be checked by blocking the circulating air inlet or temporarily disconnecting the electrical supply to the blower motor and determining that the limit control acts to shut off the main burner gas.

16. **Applicable only to boilers.**
    (a) Determine that the water pumps are in operating condition.
    (b) Test low water cutoffs, automatic feed controls, pressure and temperature limit controls, and relief valves in accordance with the manufacturer's recommendations to determine that they are in operating condition.

APPENDIX I

RECOMMENDED PROCEDURE FOR INSTALLING ELECTRICALLY OPERATED AUTOMATIC VENT DAMPER DEVICES ON EXISTING APPLIANCES

(This Appendix is informative and is not a part of the Code.)

This procedure is intended as a guide to aid in safely installing an electrically operated automatic vent damper device on an existing appliance.

This procedure is based on the assumption that the history of the specific appliance has been one of safe and satisfactory operation.

This procedure is predicated on central furnace, boiler and water heater installations, and it should be recognized that generalized procedures cannot anticipate all situations. Accordingly, in some cases deviation from this procedure may be necessary to determine safe operation of the equipment.

The following steps should be followed in making the modifications:

1. Perform a safety inspection of the existing appliance installation. See Appendix H for a recommended procedure for such a safety inspection.
2. Shut off all gas and electricity to the appliance. To shut off gas use the shutoff valve in the supply line to the appliance.
3. Install the damper device in strict accordance with the manufacturer's installation instructions. Make certain the device is not located in that portion of the venting system which serves any appliance other than the one for which the damper is installed.
4. Make certain wiring connections are tight and wires are positioned and secured so they will not be able to contact high temperature locations.
5. When an additional automatic valve has been incorporated or an existing gas control replaced, conduct a gas leakage test of the appliance piping and control system downstream of the shutoff valve in the supply line to the appliance.
6. Visually inspect the modified venting system for proper horizontal pitch.
7. Check that the damper operates properly and is properly sequenced with the appliance operating controls so that it opens

when there is a call for heat and closes when the appliance is in a standby condition.

NOTE: If a boiler gas valve is sequenced by the aquastat, determine that the damper opens prior to the opening of the gas valve.

8. Determine the amperage draw of the gas control circuit and damper device.
   (a) Check appliance transformer for adequate capacity.
   (b) Check heat anticipator in comfort thermostat to determine it is properly adjusted.

9. Sequence the appliance through at least three normal operating cycles.

10. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliance is located and other spaces of the building. Turn on clothes dryers. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.

11. Place appliance in operation. Follow the lighting instructions. Adjust thermostat so appliance will operate continuously.

12. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use a draft gage, flame of a match or candle, or smoke from a cigarette, cigar, or pipe.

13. (a) Visually determine that main burner gas is burning properly: i.e., no floating, lifting, or flashback. Adjust the primary air shutter(s) as required.
    (b) If appliance is equipped with high and low flame controlling or flame modulation, check for proper main burner operation at low flame.

14. Determine that the pilot(s) is burning properly and that main burner ignition is satisfactory by interrupting and reestablishing the electrical supply to the appliance in any convenient manner. Test the pilot safety device to determine it is operating properly by extinguishing the pilot burner(s) when the main burner(s) is off and determining, after 3 minutes, that the main burner gas does not flow upon a call for heat.

15. **Applicable only to furnaces.** Check both the limit control and the fan control for proper operation. Limit control operation can be checked by blocking the circulating air inlet or temporarily disconnecting the electrical supply to the blower motor and determining that the limit control acts to shut off the main burner gas.

16. **Applicable only to boilers.**
    - (a) Determine that the water pumps are in operating condition.
    - (b) Test low water cutoffs, automatic feed controls, pressure and temperature limit controls and relief valves in accordance with the manufacturer's recommendations to determine they are in operating condition.
17. Label the damper device (see 9.3) with information as to:
    - (a) Name of qualified agency responsible for damper installation.
    - (b) Date of installation.

APPENDIX J

RECOMMENDED PROCEDURE FOR INSTALLING MECHANICALLY ACTUATED AUTOMATIC VENT DAMPER DEVICES ON EXISTING APPLIANCES

(This Appendix is informative and is not a part of the Code.)

This procedure is intended as a guide to aid in safely installing a mechanically actuated automatic vent damper device on an existing appliance.

This procedure is based on the assumption that the history of the specific appliance has been one of safe and satisfactory operation.

This procedure is predicated on central furnace, boiler and water heater installations, and it should be recognized that generalized procedures cannot anticipate all situations. Accordingly, in some cases deviation from this procedure may be necessary to determine safe operation of the equipment.

The following steps should be followed in making the modifications:

1. Perform a safety inspection of the existing appliance installation. See Appendix H for a recommended procedure for such a safety inspection.
2. Shut off all gas and electricity to the appliance. To shut off gas use the shutoff valve in the supply line to the appliance.
3. Install the damper device in strict accordance with the manufacturer's installation instructions. Make certain the device is not located in that portion of the venting system which serves any appliance other than the one for which the damper is installed.
4. Make certain wiring and mechanical connections are tight and wires are positioned and secured so they will not be able to contact high temperature locations.
5. When an additional automatic valve has been incorporated or an existing gas control replaced, conduct a gas leakage test of the appliance piping and control system downstream of the shutoff valve in the supply line to the appliance.
6. Visually inspect the modified venting system for proper horizontal pitch.
7. Check that the damper operates properly and is properly sequenced with the appliance operating controls so that it opens

when there is a call for heat and closes when the appliance is in a standby condition.

NOTE: If a boiler gas valve is sequenced by the aquastat, determine that the damper opens prior to the opening of the gas valve.

8. Determine the amperage draw of the gas control circuit and damper device.
   (a) Check appliance transformer for adequate capacity.
   (b) Check heat anticipator in comfort thermostat to determine it is properly adjusted.

9. Sequence the appliance through at least three normal operating cycles.

10. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliance is located and other spaces of the building. Turn on clothes dryers. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.

11. Place appliance in operation. Follow the lighting instructions. Adjust thermostat so appliance will operate continuously.

12. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use a draft gage, flame of a match or candle, or smoke from a cigarette, cigar, or pipe.

13. (a) Visually determine that main burner gas is burning properly: i.e., no floating, lifting, or flashback. Adjust the primary air shutter(s) as required.
   (b) If appliance is equipped with high and low flame controlling or flame modulation, check for proper main burner operation at low flame.

14. Determine that the pilot(s) is burning properly and that main burner ignition is satisfactory by interrupting and reestablishing the electrical supply to the appliance in any convenient manner. Test the pilot safety device to determine it is operating properly by extinguishing the pilot burner(s) when the main burner(s) is off and determining, after 3 minutes, that the main burner gas does not flow upon a call for heat.

15. Applicable only to furnaces. Check both the limit control and the fan control for proper operation. Limit control operation can be checked by blocking the circulating air inlet or temporarily disconnecting the electrical supply to the blower motor and determining that the limit control acts to shut off the main burner gas.

16. Applicable only to boilers.
   (a) Determine that the water pumps are in operating condition.

  (b) Test low water cutoffs, automatic feed controls, pressure and temperature limit controls and relief valves in accordance with the manufacturer's recommendations to determine they are in operating condition.

17. Label the damper device (see 9.3) with information as to:
  (a) Name of qualified agency responsible for damper installation.
  (b) Date of installation.

APPENDIX K

RECOMMENDED PROCEDURE FOR INSTALLING THERMALLY ACTUATED AUTOMATIC VENT DAMPER DEVICES ON EXISTING APPLIANCES

(This Appendix is informative and is not a part of the Code.)

This procedure is intended as a guide to aid in safely installing a thermally actuated automatic vent damper device on an existing appliance.

This procedure is based on the assumption that the history of the specific appliance has been one of safe and satisfactory operation.

This procedure is predicated on central furnace, boiler and water heater installations, and it should be recognized that generalized procedures cannot anticipate all situations. Accordingly, in some cases deviation from this procedure may be necessary to determine safe operation of the equipment.

The following steps should be followed in making the modifications:

1. Perform a safety inspection of the existing appliance installation. See Appendix H for a recommended procedure for such a safety inspection.
2. Shut off all gas and electricity to the appliance. To shut off gas use the shutoff valve in the supply line to the appliance.
3. Install the damper device in strict accordance with the manufacturer's installation instructions. Make certain the device is not located in that portion of the venting system which serves any appliance other than the one for which the damper is installed.
4. Make certain wiring connections are tight and wires are positioned and secured so they will not be able to contact high temperature locations.
5. When an additional automatic valve has been incorporated or an existing gas control replaced, conduct a gas leakage test of the appliance piping and control system downstream of the shutoff valve in the supply line to the appliance.
6. Visually inspect the modified venting system for proper horizontal pitch.
7. Check the installation to determine there is no physical obstruction or deformation which could impair damper operation.

8. Determine the amperage draw of the gas control circuit and damper device.
   (a) Check appliance transformer for adequate capacity.
   (b) Check heat anticipator in comfort thermostat to determine it is properly adjusted.

9. Sequence the appliance through at least three normal operating cycles.

10. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliance is located and other spaces of the building. Turn on clothes dryers. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.

11. Place appliance in operation. Follow the lighting instructions. Adjust thermostat so appliance will operate continuously.

12. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use a draft gage, flame of a match or candle, or smoke from a cigarette, cigar, or pipe.

13. (a) Visually determine that main burner gas is burning properly: i.e., no floating, lifting, or flashback. Adjust the primary air shutter(s) as required.
   (b) If appliance is equipped with high and low flame controlling or flame modulation, check for proper main burner operation at low flame.

14. Determine that the pilot(s) is burning properly and that main burner ignition is satisfactory by interrupting and reestablishing the electrical supply to the appliance in any convenient manner. Test the pilot safety device to determine it is operating properly by extinguishing the pilot burner(s) when the main burner(s) is off and determining, after 3 minutes, that the main burner gas does not flow upon a call for heat.

15. Label the damper device (see 9.3) with information as to:
   (a) Name of qualified agency responsible for damper installation.
   (b) Date of installation.

248 CMR 6.00: LIQUIFIED PETROLEUM GASES - 1983 ANSI/NFPA 58

Contents

Chapter 1 General Provisions 58-11
1-1 Introduction 58-11
1-1.1 General Properties of LP-Gas 58-11
1-1.2 Federal Regulations 58-11
1-2 Scope 58-12
1-2.1 Liquefied Petroleum Gas 58-12
1-2.2 Application of Standard 58-12
1-2.3 Nonapplication of Standard 58-12
1-2.4 Retroactivity 58-13
1-3 Acceptance of Equipment and Systems 58-14
1-3.1 Method of Acceptance 58-14
1-4 LP-Gas Odorization 58-15
1-4.1 LP-Gas to be Odorized 58-15
1-5 Notification of Installations 58-15
1-5.1 Fixed Installations 58-15
1-5.2 Temporary Installations 58-15
1-6 Personnel 58-15
1-6.1 Qualification of personnel 58-15
1-7 Definitions, Glossary of Terms and Abbreviations 58-16

Chapter 2 LP-Gas Equipment and Appliances 58-25
2-1 Scope 58-25
2-1.1 Application 58-25
2-2 Containers 58-25
2-2.1 General 58-25
2-2.2 Container Design or Service Pressure 58-26
2-2.3 Container Openings 58-28
2-2.4 Portable Container Appurtenance Physical Damage Protection 58-28
2-2.5 Containers with Attached Supports 58-29
2-2.6 Container Markings 58-31
2-3 Container Appurtenances 58-32
2-3.1 General 58-32
2-3.2 Pressure Relief Devices 58-33
2-3.3 Connections for Flow Control (Filling, Withdrawal, Equalizing) 58-34
2-3.4 Liquid Level Gaging Devices 58-37
2-3.5 Pressure Gauges 58-39
2-3.6 Other Container Connections 58-39

2-4 Piping (including hose), Fittings and Valves 58-39
2-4.1 General 58-39
2-4.2 Pipe 58-39
2-4.3 Tubing 58-40
2-4.4 Pipe and Tubing Fittings 58-40
2-4.5 Valves, Other than Container Valves 58-41
2-4.6 Hose, Quick Connectors, Hose Connections and Flexible Connectors 58-42
2-4.7 Hydrostatic Relief Valves 58-43
2-5 Equipment 58-43
2-5.1 General 58-43
2-5.2 Pumps 58-44
2-5.3 Compressors 58-44
2-5.4 Vaporizers, Tank Heaters, Vaporizing-Burners and Gas-Air Mixers 58-44
2-5.5 Strainers 58-49
2-5.6 Meters 58-49
2-5.7 Dispensing Devices 58-50
2-5.8 Regulators 58-50
2-5.9 Sight Flow Glasses 58-51
2-6 Appliances 58-51
2-6.1 General 58-51
2-6.2 Approved Appliances 58-51
2-6.3 Provisions for Appliances 58-51

Chapter 3 Installation of LP-Gas Systems 58-53
3-1 Scope 58-53
3-1.1 Application 58-53
3-2 General Provisions 58-53
3-2.1 Application 58-53
3-2.2 Location of Containers 58-54
3-2.3 Installation of Containers 58-58
3-2.4 Installation of Container Appurtenances 58-62
3-2.5 Regulator Installation 58-65
3-2.6 Piping System Service Limitations 58-66
3-2.7 Installation of Pipe, Tubing, Pipe and Tubing Fittings, Valves and Hose 58-67
3-2.8 Hydrostatic Relief Valve Installation 58-70
3-2.9 Testing Piping Systems 58-70
3-2.10 Equipment Installation 58-71
3-3 Distributing and Industrial LP-Gas Systems 58-73
3-3.1 Application 58-73
3-3.2 General 58-73
3-3.3 Installation of Liquid Transfer Facilities 58-73
3-3.4 Installation of Gas Distribution Facilities 58-74
3-3.5 Installation of Electrical Equipment 58-75

- 3-3.6 Protection Against Tampering for Section 3-3 Systems 58-75
- 3-3.7 Lighting 58-75
- 3-3.8 Ignition Source Control 58-75
- 3-4 LP-Gas Systems in Buildings or on the Roofs of Buildings 58-75
  - 3-4.1 Application 58-75
  - 3-4.2 General Provisions for Containers, Equipment, Piping and Appliances 58-76
  - 3-4.3 Buildings Under Construction or Undergoing Major Renovation 58-78
  - 3-4.4 Buildings Undergoing Minor Renovation When Frequented by the Public 58-79
  - 3-4.5 Buildings Housing Industrial Occupancies 58-80
  - 3-4.6 Buildings Housing Educational and Institutional Occupancies 58-80
  - 3-4.7 Temporary Heating in Buildings in Emergencies 58-80
  - 3-4.8 Use in Buildings for Demonstrations or Training, or in Small Containers 58-81
  - 3-4.9 Permanent Installations Using Portable Containers on Roofs 58-81
  - 3-4.10 Liquid Piped into Buildings or Structures 58-82
- 3-5 Installation of Appliances 58-83
  - 3-5.1 Application 58-83
  - 3-5.2 Reference Standards 58-83
- 3-6 Engine Fuel Systems 58-84
  - 3-6.1 Application 58-84
  - 3-6.2 General Purpose Vehicle Engines Fueled by LP-Gas . 58-84
  - 3-6.3 Industrial (and Forklift) Trucks Powered by LP-Gas 58-96
  - 3-6.4 General Provisions for Vehicles Having Engines Mounted on Them 58-98
  - 3-6.5 Engine Installation Other Than on Vehicle 58-98
  - 3-6.6 Garaging of Vehicles 58-99
- 3-7 Vaporizer Installation 58-99
  - 3-7.1 Application 58-99
  - 3-7.2 Installation of Indirect-Fired Vaporizers 58-99
  - 3-7.3 Installation of Direct Gas-Fired Vaporizers 58-101
  - 3-7.4 Installation of Direct Gas-Fired Tank Heaters 58-102
  - 3-7.5 Installation of Vaporizing-Burners 58-103
  - 3-7.6 Installation of Waterbath Vaporizers 58-103
- 3-8 Ignition Source Control 58-104
  - 3-8.1 Application 58-104
  - 3-8.2 Electrical Equipment 58-104
  - 3-8.3 Other Sources of Ignition 58-104
  - 3-8.4 Control of Ignition Sources During Transfer 58-109

3-9 LP-Gas Systems on Vehicles (Other Than Engine Fuel Systems) 58-110
3-9.1 Application 58-110
3-9.2 Construction, Location, Mounting and Protection of Containers and Systems 58-110
3-9.3 Equipment Installation 58-115
3-9.4 Appliance Installation 58-115
3-9.5 General Precautions 58-116
3-10 Fire Protection 58-117
3-10.1 Application 58-117
3-10.2 General 58-117
3-10.3 Special Protection 58-117

Chapter 4 LP-Gas Liquid Transfer 58-120
4-1 Scope 58-120
4-1.1 Application 58-120
4-2 Operational Safety 58-120
4-2.1 Transfer Personnel 58-120
4-2.2 Containers to be Filled 58-120
4-2.3 Arrangement and Operation of Transfer Systems . . 58-121
4-3 Location of Transfer Operations 58-122
4-3.1 General 58-122
4-3.2 Containers in Stationary Installations 58-122
4-3.3 Containers in Nonstationary Installations 58-122
4-3.4 Cargo Vehicles 58-123
4-4 Venting LP-Gas to the Atmosphere 58-123
4-4.1 General 58-123
4-4.2 Purging 58-124
4-4.3 Emergency Venting 58-124
4-5 Quantity of LP-Gas in Containers 58-125
4-5.1 Application 58-125
4-5.2 LP-Gas Capacity of Containers 58-125
4-5.3 Compliance With Maximum Permitted Filling Density Provisions 58-126

Chapter 5 Storage of Portable Containers Awaiting Use or Resale 58-134
5-1 Scope 58-134
5-1.1 Application 58-134
5-2 General Provisions 58-134
5-2.1 General Location of Containers 58-134
5-2.2 Protection of Valves on Containers in Storage 58-135
5-3 Storage within Buildings 58-135
5-3.1 Storage within Buildings Frequented by the Public . 58-135
5-3.2 Storage within Buildings Not Frequented by the Public (Such as Industrial Buildings) 58-135
5-3.3 Storage within Special Buildings or Rooms 58-135

5-4 Storage Outside of Buildings 58-136
5-4.1 Location of Storage Outside of Buildings 58-136
5-4.2 Protection of Containers 58-136
5-4.3 Alternate Location and Protection of Storage 58-136
5-5 Fire Protection 58-136
5-5.1 Fire Extinguisher Requirements 58-136

Chapter 6 Truck Transportation of LP-Gas 58-137
6-1 Scope 58-137
6-1.10 Application 58-137
6-2 Transportation in Portable Containers 58-138
6-2.1 Application 58-138
6-2.2 Transportation of DOT Specification Cylinders or Portable ASME Containers 58-138
6-2.3 Transportation of Portable Containers of More than 1,000 Pounds (454 kg) Water Capacity 58-138
6-2.4 Fire Extinguishers 58-139
6-3 Transportation in Cargo Vehicles 58-140
6-3.1 Application 58-140
6-3.2 Containers Mounted on, or a Part of, Cargo Vehicles 58-140
6-3.3 Piping (Including Hose), Fittings and Valves 58-141
6-3.4 Equipment 58-142
6-3.5 Protection of Container Appurtenances, Piping System and Equipment 58-143
6-3.6 Painting and Marking Liquid Cargo Vehicles 58-143
6-3.7 Fire Extinguishers 58-143
6-3.8 Chock Blocks for Liquid Cargo Vehicles 58-143
6-3.9 Exhaust Systems 58-143
6-3.10 Smoking Prohibition 58-143
6-4 Trailers, Semitrailers, Movable Fuel Storage Tenders or Farm Carts 58-144
6-4.1 Application 58-144
6-4.2 Trailers or Semitrailers Comprising Parts of Section 6-3 Vehicles 58-144
6-4.3 Trailers, Including Movable Storage Tenders or Farm Carts 58-144
6-5 Transportation of Stationary Containers to and from Point of Installation 58-144
6-5.1 Application 58-144
6-5.2 Transportation of Containers 58-145
6-6 Parking and Garaging Vehicles Used to Carry LP-Gas Cargo 58-145
6-6.1 Application 58-145
6-6.2 Parking 58-145

Chapter 7 Buildings or Structures Housing LP-Gas Distribution Facilities 58-148
7-1 Scope 58-148
7-1.1 Application 58-148
7-2 Separate Structures or Buildings 58-148
7-2.1 Construction of Structures or Buildings 58-148
7-2.2 Structure or Building Ventilation 58-148
7-2.3 Structure or Building Heating 58-149
7-3 Attached Structures or Rooms within Structures 58-149
7-3.1 Construction of Attached Structures 58-149
7-2.2 Construction of Rooms within Structures 58-149

Appendix A Properties of LP-Gases 58-151

Appendix B Design, Construction and Requalification of DOT (ICC) Cylinder Specification Containers 58-154

Appendix C Design of ASME and API-ASME Containers 58-159

Appendix D Pressure Relief Devices 58-165

Appendix E Liquid Volume Tables, Computations and Graphs 58-170

Appendix F Wall Thickness of Copper Tubing 58-177

Appendix G Container Spacing 58-178

Appendix H Referenced Publications 58-181

Index 58-185

Standard for the Storage and Handling of Liquefied Petroleum Gases

NFPA 58-1983

Metric equivalents in this standard are approximate and shall not be used to lessen any provision.

Chapter 1 General Provisions

1-1 Introduction.

1-1.1 General Properties of LP-Gas.

1-1.1.1 LP-Gases, as defined in this standard (*see 1-2.1*), are gases at normal room temperatures and atmospheric pressure. They liquefy under moderate pressure, readily vaporizing upon release of this pressure. It is this property which permits transporting and storing them in concentrated liquid form, while normally using them in vapor form. The potential fire hazard of LP-Gas vapor is comparable to that of natural or manufactured gas, except that LP-Gas vapors are heavier than air. The ranges of flammability are considerably narrower and lower than those of natural or manufactured gas. For example, the lower flammable limits of the more commonly used LP-Gases are: Propane, 2.15 percent; Butane, 1.55 percent. These figures represent volumetric percentages of gas in gas-air mixtures.

1-1.1.2 The boiling point of pure normal butane is 31°F (minus 0.56°C); of pure propane minus 44°F (minus 42.2°C). Both products are liquids at atmospheric pressure at temperatures lower than their boiling points. Vaporization is rapid at temperatures above the boiling point, thus liquid propane normally does not present a flammable liquid hazard. For additional information on these and other properties of the principal LP-Gases, see Appendix A.

1-1.2 Federal Regulations.

1-1.2.1 Regulations of the US Department of Transportation (DOT) are referenced throughout this standard. Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission (ICC).

1-2 Scope.

1-2.1 Liquefied Petroleum Gas.

1-2.1.1 As used in this standard, the terms "liquefied petroleum gas(es)', "LP-Gas" and "LPG" are synonymous and shall mean and include any material having a vapor pressure not exceeding that allowed for commercial propane composed predominantly of the following hydrocarbons, either by themselves or as mixtures: Propane, Propylene, Butane (normal butane or iso-butane) and Butylene (including isomers).

1-2.1.2 LP-Gas stored or used in systems within the scope of this standard shall not contain ammonia. When such a possibility exists (such as may result from the dual use of transportation or storage equipment), the LP-Gas shall be tested as follows:

(a) Allow a moderate vapor stream of the product to be tested to escape from the container. A rotary, slip tube or fixed level gauge is a convenient vapor source.

(b) Wet a piece of red litmus paper by pouring distilled water over it while holding it with clean tweezers.

(c) Hold the wetted litmus paper in the vapor stream from the container for 30 seconds.

(d) The appearance of any blue color on the litmus paper indicates that ammonia is present in the product.

NOTE 1: Since the red litmus paper will turn blue when exposed to any basic (alkaline) solution, care in making the test and interpreting the results is required. Tap water, saliva, perspiration or hands that have been in contact with water having a pH greater than 7, or with any alkaline solution, will give erroneous results.

NOTE 2: For additional information on the nature of this problem and conducting the test, see *Recommendations for Prevention of Ammonia Contamination of LP-Gas*, published by the National LP-Gas Association.

1-2.2 Application of Standard.

1-2.2.1 This standard applies to the highway transportation of LP-Gas and to the design, construction, installation and operation of all LP-Gas systems except those designated by 1-2.3.

1-2.3 Nonapplication of Standard.

1-2.3.1 This standard does not apply to:

(a) LP-Gas refrigerated storage systems.

(b) Marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants or tank farms ("tank farm" storage at industrial locations is covered by NFPA 58).*

(c) LP-Gas (including refrigerated storage) at utility gas plants. NFPA 59, *Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants*, shall apply.

(d) Chemical plants where specific approval of construction and installation plans, based on substantially similar requirements, is obtained from the authority having jurisdiction.

(e) LP-Gas used with oxygen. NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes*, and ANSI Z49.1, *Safety in Cutting and Welding*, shall apply.

(f) Those portions of LP-Gas systems covered by NFPA 54 (ANSI Z223.1), *National Fuel Gas Code*.

NOTE: Several types of LP-Gas systems are not covered by the *National Fuel Gas Code* as noted in 1.1.1(b) therein. These include, but are not restricted to, most portable applications; many farm installations; vaporization, mixing and gas manufacturing; temporary systems, e.g., in construction; and systems on vehicles. For those systems within its scope, the *National Fuel Gas Code* is applicable to those portions of a system downstream of the outlet of the first stage of pressure regulation.

(g) Transportation by air (including use in hot air balloons), rail or water under the jurisdiction of the US Department of Transportation.

(h) Marine fire protection. NFPA 302, *Standard for Pleasure and Commercial Motor Craft*, shall apply.

1-2.4 Retroactivity.

1-2.4.1 Unless otherwise stated, the provisions of this standard shall not be applied retroactively.

(a) Existing plants, appliances, equipment, buildings, structures and installations for the storage, handling or use of LP-Gas in compliance with the provisions of this standard in effect at the time of manufacture or installation may be continued in use provided that such continued use does not constitute a distinct hazard to life or adjoining property.

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*For LP-Gas installations (including refrigerated storage) at such facilities, it is recommended that API Standard 2510-1978, "The Design and Construction of Liquefied Petroleum Gas Installations at Marine and Pipeline Terminals, Natural Gas Processing Plants, Refineries, Petrochemical Plants and Tank Farms," be applied. Available from the American Petroleum Institute, 2101 L St., N.W., Washington, DC 20037.

(b) The stocks of equipment and appliances on hand in such locations as manufacturer's storage, distribution warehouses, and dealer's storage and showrooms in compliance with the provisions of this standard in effect at the time of manufacture may be placed in use (provided such use does not constitute a distinct hazard to life or adjoining property), but all new equipment and appliances manufactured after the effective date of this standard shall comply with its provisions.

1-3 Acceptance of Equipment and Systems.

1-3.1 Method of Acceptance.

1-3.1.1 Systems, or components assembled to make up systems, shall be approved (*see Section 1-7, APPROVED*) as specified in Table 1-3.

1-3.1.2 Acceptance applies to the complete system, or to the individual components of which it is comprised, as specified in Table 1-3.

Table 1-3

Containers Used	Capacity in Water Gal (m^3)	Approval Applies to:
DOT Cylinders	Up to 120 (0.454) (1,000 lb, 454 kg)	1. Container Valves and Connectors 2. Manifold Valve Assemblies 3. Regulators and Pressure Relief Devices
ASME Tanks	2,000 (7.6 m^3) or less	1. Container System, *including Regulator, or 2. Container Assembly* and Regulator separately
ASME Tanks	Over 2,000 (7.6 m^3)	1. Container Valves 2. Container Excess Flow Valves, Back Flow Check Valves, or alternate means of providing this protection such as remotely controlled Manual or Automatic Internal Valves 3. Container Gaging Devices 4. Regulators and Container Pressure Relief Devices

*Where necessary to alter or repair such systems or assemblies in the field in order to provide for different operating pressures, change from vapor to liquid withdrawal, or the like, such changes may be made by the use of approved components.

1-4 LP-Gas Odorization.

1-4.1 LP-Gas to be Odorized.

1-4.1.1 All LP-Gases shall be odorized by the addition of a warning agent of such character that they are detectable, by a distinct odor, down to a concentration in air of not over one-fifth the lower limit of flammability.[1],[2] Odorization, however, is not required if harmful in the use or further processing of the LP-Gas, or if odorization will serve no useful purpose as a warning agent in such further use or processing. (*See 1-1.1.1 and Appendix A for flammable limits of the LP-Gases.*)

1-5 Notification of Installations.

1-5.1 Fixed Installations.

1-5.1.1 Plans for fixed (stationary) installations utilizing storage containers of over 2,000 gal (7.6 m^3) individual water capacity, or with aggregate water capacity exceeding 4,000 gal (15.1 m$3), shall be submitted to the authority having jurisdiction before the installation is started. [*See also 3-4.9.1(g).]*

1-5.2 Temporary Installations.

1-5.2.1 The authority having jurisdiction shall be notified of temporary (not to exceed 6 months) installations of the sizes covered in 1-5.1.1 before the installation is started.

1-6 Personnel.

1-6.1 Qualification of Personnel.

1-6.1.1 In the interests of safety, all persons employed in handling LP-Gases shall be trained in proper handling and operating procedures.

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[1] It is recognized that no odorant will be completely effective as a warning agent in every circumstance.

[2] It is recommended that odorants be qualified as to compliance with 1-4.1.1 by tests or experience. Where qualifying is by tests, such tests should be certified to by an approved laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan in the ratio of 1.0 lb (0.45 kg) per 10,000 gal (37.9 m^3)of liquid LP-Gas has been recognized as an effective odorant. Other odorants and quantities meeting the provisions of 1-4.1.1 may be used. Research* on odorants has shown that thiophane (tetrahydrothiophene) in a ratio of at least 6.4 lb (2.9 kg) per 10,000 gal (37.9 m^3) of liquid LP-Gas may satisfy the requirements of 1-4.1.1.

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*"A New Look at Odorization Levels for Propane Gas," BERC/RI-77/1, United States Energy Research & Development Administration, Technical Information Center, September, 1977.

1-7 Definitions, Glossary of Terms and Abbreviations.

AGA. American Gas Association.

ANSI. American National Standards Institute.

API. American Petroleum Institute.

API-ASME Container (or Tank). A container constructed in accordance with the pressure vessel code jointly developed by the American Petroleum Institute and the American Society of Mechanical Engineers (*see Appendix C*).

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

ASME. American Society of Mechanical Engineers.

ASME Code. The *Boiler and Pressure Vessel Code* (Section VIII for Unfired Pressure Vessels) of the American Society of Mechanical Engineers. Only Division I of Section VIII of the ASME Code is applicable in this standard except UG-125 through UG-136 shall not apply.

ASME Container (or Tank). A container constructed in accordance with the ASME Code. (*See Appendix C.*)

ASTM. American Society for Testing and Materials.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Bureau of Explosives (B of E). An agency of the Association of American Railroads.

Cargo Tank. (Primarily a DOT designation.) A container used to transport LP-Gas over the highway as liquid cargo, either mounted on a conventional truck chassis or as an integral part of a transporting vehicle in which the container constitutes in whole, or in part, the stress member used as a frame. Essentially a permanent part of the transporting vehicle.

CGA. Compressed Gas Association, Inc.

Charging. See Filling.

Compressed Gas. Any material or mixture having in the container an absolute pressure exceeding 40 psia (276 kPa absolute) at 70°F (21.1°C), or regardless of the pressure at 70°F (21.1°C), having an absolute pressure exceeding 104 psia (717 kPa absolute) at 130°F (54.4°C).

Container. Any vessel, including cylinders, tanks, portable tanks and cargo tanks, used for the transporting or storing of the LP-Gases.

Container Appurtenances. Items connected to container openings needed to make a container a gastight entity. These include, but are not limited to, pressure relief devices; shutoff, backflow check, excess flow check and internal valves; liquid level gauges; pressure gauges and plugs.

Container Assembly. An assembly consisting essentially of the container and fittings for all container openings. These include shutoff valves, excess flow valves, liquid level gauging devices, pressure relief devices and protective housings.

Cylinder. A portable container constructed to DOT (formerly ICC) cylinder specifications or, in some cases, constructed in accordance with the ASME Code of a similar size and for similar service. The maximum size permitted under DOT specifications is 1,000 lb (454 kg) water capacity.

Direct Gas-Fired Tank Heater. A gas-fired device which applies hot gas from the heater combustion chamber directly to a portion of the container surface in contact with LP-Gas liquid.

Dispensing Device (or Dispenser). A device normally used to transfer and measure LP-Gas for engine fuel into a fuel container, serving the same purpose for an LP-Gas service station as that served by a gasoline dispenser in a gasoline service station.

Distributing Plant. A facility, the primary purpose of which is the distribution of gas, and which receives LP-Gas in tank car, truck transport or truck lots, distributing this gas to the end user by portable container (package) delivery, by tank truck or through gas piping. Such plants have bulk storage [2,000 gal (7.6 m^3) water capacity or more] and usually have container filling and truck loading facilities on the premises. So-called "bulk plants" are considered as being in this category. Normally no persons other than the plant management or plant employees have access to these facilities.

Distributing Point. A facility, other than a distributing plant or industrial plant, which normally receives gas by tank truck, and which fills small containers or the engine fuel tanks of motor vehicles on the premises. Any such facility having LP-Gas storage of 100 gal (0.4 m^3) or more water capacity, and to which persons other than the owner of the facility or his employees have access, is considered to be a distributing point. An LP-Gas service station is one type of distributing point.

DOT. US Department of Transportation.

DOT Cylinder. See Cylinder.

Emergency Shutoff Valve. A shutoff valve incorporating thermal and manual means of closing and providing for remote means of closing.

Excess Flow Valve (also called Excess-Flow Check Valve). A device designed to close when the liquid or vapor passing through it exceeds a prescribed flow rate as determined by pressure drop.

Fill, Filling. Transferring liquid LP-Gas into a container.

Filling by Volume. See Volumetric Filling.

Filling by Weight. See Weight Filling.

Fixed Liquid Level Gauge. A type of liquid level gauge using a relatively small positive shutoff valve and designed to indicate when the liquid level in a container being filled reaches the point at which this gauge or its connecting tube communicates with the interior of the container.

Fixed Maximum Liquid Level Gauge. A fixed liquid level gauge which indicates the liquid level at which the container is filled to its maximum permitted filling density.

Flexible Connector. A short [not exceeding 36 in. (1 m) overall length] component of a piping system fabricated of flexible material (such as hose) and equipped with suitable connections on both ends. LP-Gas resistant rubber and fabric (or metal), or a combination of them, or all metal may be used. Flexible connectors are used where there is the need for, or the possibility of, greater relative movement between the points connected than is acceptable for rigid pipe.

Float Gauge. A gauge constructed with a float inside the container resting on the liquid surface which transmits its position through suitable leverage to a pointer and dial outside the container indicating the liquid level. Normally the motion is transmitted magnetically through a nonmagnetic plate so that no LP-Gas is released to the atmosphere.

Gallon. US Standard. 1 US gal = 0.833 Imperial gal = 231 cu in. = 3.785 liters.

Gas. Liquefied Petroleum Gas in either the liquid or vapor state. The more specific terms "liquid LP-Gas" or "vapor LP-Gas" are normally used for clarity.

Gas-Air Mixer. A device, or system of piping and controls, which mixes LP-Gas vapor with air to produce a mixed gas of a lower heating value than the LP-Gas. The mixture thus created is normally used in industrial or commercial facilities as a substitute for some other fuel gas. The mixture may replace another fuel gas completely, or may be mixed to produce similar characteristics and mixed with the basic fuel gas. Any gas-air mixer which is designed to produce a mixture containing more than 85 percent air is not subject to the provisions of this standard.

ICC. US Interstate Commerce Commission.

ICC Cylinder. See Cylinder.

Ignition Source. See Sources of Ignition.

Industrial Plant. An industrial facility which utilizes gas incident to plant operations, with LP-Gas storage of 2,000 gal (7.6 m^3) water capacity or more, and which receives gas in tank car, truck transport or truck lots. Normally LP-Gas is used through piping systems in the plant, but may also be used to fill small containers, such as for engine fuel on industrial (i.e., forklift) trucks. Since only plant employees have access to these filling facilities, they are not considered to be distributing points.

Internal Valve. A primary shutoff valve for containers which has adequate means of actuation and which is constructed in such a manner that its seat is inside the container and that damage to parts exterior to the container or mating flange will not prevent effective seating of the valve.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Liquefied Petroleum Gas (LP-Gas or LPG). Any material having a vapor pressure not exceeding that allowed for commercial propane composed predominantly of the following hydrocarbons, either by themselves or as mixtures: Propane, Propylene, Butane (normal butane or iso-butane) and Butylenes.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Load, Loading. See Filling.

LPG. See Liquefied Petroleum Gas.

LP-Gas. Liquefied Petroleum Gas.

LP-Gas Service Station. See Distributing Point. A facility open to the public which consists of LP-Gas storage containers, piping and pertinent equipment, including pumps and dispensing devices, and any buildings, and in which LP-Gas is stored and dispensed into engine fuel containers of highway vehicles.

LP-Gas System. An assembly consisting of one or more containers with a means for conveying LP-Gas from the container(s) to dispensing or consuming devices (either continuously or intermittently) and which incorporates components intended to achieve control of quantity, flow, pressure, or state (either liquid or vapor).

Magnetic Gauge. See Float Gauge.

Movable Fuel Storage Tenders or Farm Carts. Containers not in excess of 1,200 gal (4.5 m^3) water capacity, equipped with wheels to be towed from one location to another. They are basically nonhighway vehicles, but may occasionally be moved over public roads or highways for short distances to be used as a fuel supply for farm tractors, construction machinery and similar equipment.

NFPA. National Fire Protection Association.

NLPGA. National LP-Gas Association.

Permanent Installation. See Stationary Installation.

Piping, Piping Systems. Pipe, tubing, hose and flexible rubber or metallic hose connectors made up with valves and fittings into complete systems for conveying LP-Gas in either the liquid or vapor state at various pressures from one point to another.

Point of Transfer. The location where connections and disconnections are made or where LP-Gas is vented to the atmosphere in the course of transfer operations.

Portable Container. A container designed to be readily moved, as distinguished from containers designed for stationary installations. Portable containers designed for transportation filled to their maximum filling density include "cylinders," "cargo tanks" and "portable tanks," all three of which are separately defined. Containers designed to be readily moved from one usage location to another, but substantially empty of product, are "portable storage containers" and are separately defined.

Portable Storage Container. A container similar to, but distinct from, those designed and constructed for stationary installation, designed so that it can be readily moved over the highways, substantially empty of liquid, from one usage location to another. Such containers either have legs or other supports attached, or are mounted on running gear (such as trailer or semitrailer chassis) with suitable supports, which may be of the fold-down type, permitting them to be placed or parked in a stable position on a reasonably firm and level surface. For large volume, limited duration product usage (such as at construction sites and normally for 12 months or less) portable storage containers function in lieu of permanently installed stationary containers.

Portable Tank (also called Skid Tank). A container of more than 1,000 lb (454 kg) water capacity used to transport LP-Gas handled as a "package," that is, filled to its maximum permitted filling density. Such containers are mounted on skids or runners and have all container appurtenances protected in such a manner that they can be safely handled as a "package."

PSI, PSIG and PSIA. Pounds per square inch, pounds per square inch gauge, and pounds per square inch absolute, respectively.

Pressure Relief Device. A device designed to open to prevent a rise of internal fluid pressure in excess of a specified value due to emergency or abnormal conditions. (*See ANSI B95.1, Terminology for Pressure Relief Devices.*)

Quick Connectors. Devices used for quick connections of the acme thread or lever-cam types. This does not include devices used for cylinder-filling connections.

Rotary Gauge. A variable liquid level gauge consisting of a small positive shutoff valve located at the outer end of a tube, the bent inner end of which communicates with the container interior. The tube is installed in a fitting designed so that the tube can be rotated with a pointer on the outside to indicate the relative position of the bent inlet end. The length of the tube and the configuration to which it is bent is suitable for the range of liquid levels to be gauged. By a suitable outside scale, the level in the container at which the inner end begins to receive liquid can be determined by the pointer position on the scale at which a liquid-vapor mixture is observed to be discharged from the valve.

Skid Tank. See Portable Tank.

Slip Tube Gauge. A variable liquid level gauge in which a relatively small positive shutoff valve is located at the outside end of a straight tube, normally installed vertically, and communicates with the container interior. The installation fitting for the tube is designed so that the tube can be slipped in and out of the container and the liquid level at the inner end determined by observing when the shutoff valve vents a liquid-vapor mixture.

Sources of Ignition. Devices or equipment which, because of their modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable LP-Gas vapor-air mixtures when introduced into such a mixture or when such a mixture comes into contact with them, and which will permit propagation of flame away from them.

Special Protection. A means of limiting the temperature of an LP-Gas container for purposes of minimizing the possibility of failure of the container as the result of fire exposure.

When required in this standard, special protection consists of any of the following: applied insulating coatings, mounding, burial, water spray fixed systems or fixed monitor nozzles, meeting the criteria specified in this standard (*see 3-10.3*), or by any means listed (*see definition of "Listed"*) for this purpose.

Stationary Installation (also called "Fixed" or "Permanent" Installation). An installation of LP-Gas containers, piping and equipment for use indefinitely at a particular location; an installation not normally expected to change in status, condition or place.

UL. Underwriters Laboratories, Inc.

Universal Cylinder. A DOT cylinder specification container, constructed and fitted with appurtenances in such a manner that it may be connected for service with its longitudinal axis in either the vertical or the horizontal position, and so that its fixed maximum liquid level gauge, pressure relief device(s) and withdrawal appurtenance will function properly in either position.

Vaporizer. A device for converting liquid LP-Gas to vapor by means other than atmospheric heat transfer through the surface of the container.

Vaporizing-Burner (also called Vaporizer-Burner and Self-Vaporizing Liquid Burner). A burner containing an integral vaporizer which receives LP-Gas in liquid form and which uses part of the heat generated by the burner to vaporize the liquid in the burner so that it is burned as a vapor.

Vaporizer, Direct-Fired. A vaporizer in which heat furnished by a flame is directly applied to some form of heat exchange surface in contact with the liquid LP-Gas to be vaporized.

Vaporizer, Indirect (also called Indirect-Fired). A vaporizer in which heat furnished by steam, hot water or other heating medium is applied to a vaporizing chamber or to tubing, pipe coils or other heat exchange surface containing the liquid LP-Gas to be vaporized; the heating of the medium used being at a point remote from the vaporizer.

Vaporizer, Waterbath (also called Immersion Type). A vaporizer in which a vaporizing chamber, tubing, pipe coils, or other heat exchange surface containing liquid LP-Gas to be vaporized is immersed in a temperature controlled bath of water, water-glycol combination, or other heat transfer medium, which is heated by an immersion heater not in contact with the LP-Gas heat exchange surface.

Variable Liquid Level Gauge. A device to indicate the liquid level in a container throughout a range of levels. See Float, Rotary and Slip Tube Gauge.

Volumetric Filling. Filling a container by determination of the volume of LP-Gas in the container.Unless a container is filled by a fixed maximum liquid level gauge, correction of the volume for liquid temperature is necessary.

Volumetric Loading. See Volumetric Filling.

Water Capacity. The amount of water, in either lb or gal, at 60°F (15.6°C) required to fill a container liquid full of water.

Weight Filling. Filling containers by weighing the LP-Gas in the container. No temperature determination or correction is required as a unit of weight is a constant quantity regardless of temperature.

Chapter 2 LP-Gas Equipment and Appliances

2-1 Scope.

2-1.1 Application.

2-1.1.1 This chapter includes the basic provisions for individual components, or for such components shop-fabricated into subassemblies, container assemblies or complete container systems.

2-1-1.2 The field assembly of components, subassemblies, container assemblies or complete container systems into complete LP-Gas systems is covered by Chapter 3. See Definition of LP-Gas System.

2-2 Containers.

2-2.1 General.

2-2.1.1 This section includes design, fabrication and marking provisions for containers, and features normally associated with container fabrication, such as container openings, appurtenances required for these openings to make the containers gastight entities, physical damage protecting devices, and container supports attached to, or furnished with the container by the manufacturer.

2-2.1.2 Containers shall comply with 2-2.1.3 or shall be designed, fabricated, tested and marked using criteria which incorporate an investigation to determine that it is safe and suitable for the proposed service, is recommended for that service by the manufacturer, and is acceptable to the authority having jurisdiction.

2-2.1.3 Containers shall be designed, fabricated, tested and marked (or stamped) in accordance with the Regulations of the US Department of Transportation (DOT)[1], the *Rules for the Construction of Unfired Pressure Vessels*, Section VIII, Division 1, ASME *Boiler and Pressure Vessel Code*, or the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*[2] applicable at the date of manufacture; and as follows:

(a) Adherence to applicable ASME Code Case Interpretations and Addenda shall be considered as compliance with the ASME Code.

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[1] Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply.

[2] Construction of containers to the API-ASME Code has not been authorized after July 1, 1961.

(b) Containers fabricated to earlier editions of Regulations, Rules or Codes listed in 2-2.1.3 and the ICC Rules for Construction of Unfired Pressure Vessels, prior to April 1, 1967, may continue in use in accordance with 1-2.4.1. (*See Appendices B and C.*)

2-2.1.4 Containers complying with 2-2.1.3 may be reused, or reinstalled, as follows:

(a) The owner of a container shall be responsible for its suitability for continued service. DOT cylinders shall not be refilled, continued in service or transported unless they are properly qualified or requalified for LP-Gas service in accordance with DOT regulations.

(b) Containers which have been involved in a fire shall have been requalified for continued service before being reused or reinstalled as follows:

(1) DOT containers shall be requalified by a manufacturer of the type of cylinder to be requalified or by a repair facility authorized by the Bureau of Explosives and approved by DOT.

Exception: DOT 4E Specification (aluminum) cylinders shall be permanently removed from service.

(2) ASME or API-ASME containers shall be retested, using the hydrostatic test procedure applicable at the time of original fabrication.

2-2.1.5 Containers for general use shall not have individual water capacities greater than 120,000 gal (454 m^3). Containers in service stations shall not have individual water capacities greater than 30,000 gal (114 m^3).

2-2.1.6 Welding for the repair or alterations of containers shall comply with the Regulations, Rules or Code under which the container was fabricated. Other welding is permitted only on saddle plates, lugs or brackets attached to the container by the container manufacturer.

2-2.1.7 Heating or cooling coils shall not be installed inside storage containers.

2-2.2 Container Design or Service Pressure.

2-2.2.1 The minimum design, or service, pressure of DOT specification containers shall be in accordance with the appropriate DOT regulations.

2-2.2.2 The minimum design pressure for ASME containers shall be in accordance with Table 2-2.2.2.

Table 2-2.2.2

For Gases with Vapor Pressure in psig (MPa gauge) at 100°F (37.8°C) not to Exceed	Minimum Design Pressure in psig (MPa gauge) ASME Code, Section VIII, Division 1, 1980 Edition (Note 1)
80 (0.6)	100 (0.7) (Note 2)
100 (0.7)	125 (0.9)
125 (0.9)	156 (1.1)
150 (1.0)	187 (1.3)
175 (1.2)	219 (1.5)
215 (1.5)	250 (1.7)
215 (1.5)	312.5 (2.2) (Note 3)

Note 1. See Appendix C for information on earlier ASME or API-ASME Code.

Note 2. New containers for 100 psig (0.7 MPa gauge) design pressure (or equivalent under earlier codes) not authorized after December 31, 1947.

Note 3. See 3-6.2.2 for certain service conditions which require a higher pressure relief valve start-to-leak setting.

2-2.2.3 In addition to the applicable provisions for horizontal ASME storage containers, vertical ASME storage containers over 2,000 gal (7.6 m^3) water capacity shall comply with 2-2.2.3(a) through (e).

(a) Containers shall be designed to be self-supporting without the use of guy wires and shall satisfy proper design criteria taking into account wind, seismic (earthquake) forces, and hydrostatic test loads.

(b) Design pressure (*see Table 2-2.2.2*) shall be interpreted as the pressure at the top head with allowance made for increased pressure on lower shell sections and bottom head due to the static pressure of the product.

(c) Wind loading on containers shall be based on wind pressures on the projected area at various height zones aboveground in accordance with "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," ANSI A58.1. Wind speeds shall be based on a Mean Occurrence Interval of 100 years.

(d) Seismic loading on containers shall be based on forces recommended in the *Uniform Building Code*. In those areas identified as zones 3 and 4 on the Seismic Risk Map of the United States, Figures 1, 2 and 3 of Chapter 23 of the UBC, a seismic analysis of the proposed installation shall be made which meets the approval of the authority having jurisdiction.

(e) Containers shall be fabricated with lifting lugs or some other suitable means to facilitate erection in the field.

2-2.3 Container Openings.

2-2.3.1 Containers shall be equipped with openings suitable for the service in which the container is to be used. Such openings may be either in the container proper or in the manhole cover, or part in one and part in the other.

2-2.3.2 Containers of more than 30 gal (0.1 m^3) and less than 2,000 gal (7.6 m^3) water capacity, designed to be filled volumetrically, and manufactured after December 1, 1963, shall be equipped for filling into the vapor space.

2-2.3.3 ASME containers of 2,000 gal (7.6 m^3) or less water capacity shall have not more than two plugged openings.

2-2.3.4 Containers of 125 gal (0.5 m^3) or more water capacity manufactured after July 1, 1961, shall be provided with a connection for liquid evacuation, not smaller than ¾ in. National Pipe Thread. A plugged opening will not comply with this provision.

2-2.3.5 Containers of more than 2,000 gal (7.6 m^3) water capacity and all containers installed in LP-Gas service stations shall be provided with an opening for a pressure gauge (*see 2-3.5.2*).

2-2.3.6 Connections for pressure relief valves shall be located and installed in such a way as to have direct communication with the vapor space, whether the container is in storage or in use. If located in a well inside the container with piping to the vapor space, the design of the well and piping shall permit sufficient pressure relief valve relieving capacity. If located in a protecting enclosure, design shall be such as to permit this enclosure to be protected against corrosion and to permit inspection.

2-2.3.7 Containers to be filled on a volumetric basis manufactured after December 31, 1965, shall be fabricated so that they can be equipped with a fixed liquid level gauge(s) capable of indicating the maximum permitted filling level(s) in accordance with 4-5.2.3.

2-2.4 Portable Container Appurtenance Physical Damage Protection.

2-2.4.1 Portable containers of 1,000 lb (454 kg) [nominal 120 gal (0.5 m^3)] water capacity or less shall incorporate protection against physical damage to container appurtenances and immediate connections to these while in transit, storage, while being moved into position for use, and when in use except in residential and commercial installations, by:

(a) Recessing connections into the container so that valves will not be struck if the container is dropped on a flat surface, or,

(b) A ventilated cap or collar designed to permit adequate pressure relief valve discharge and capable of withstanding a blow from any direction equivalent to that of a 30 lb (14 kg) weight dropped 4 ft (1.2 m). Construction shall be such that the force of the blow will not be transmitted to the valve. Collars shall be designed so that they do not interfere with the free operation of the cylinder valve.

2-2.4.2 Portable containers of more than 1,000 lb (454 kg) [nominal 120 gal (0.5 m^3)] water capacity, including skid tanks or for use as cargo containers, shall incorporate protection against physical damage to container appurtenances by recessing, protective housings, or by location on the vehicle. Such protection shall comply with the provisions under which the tanks are fabricated, and shall be designed to withstand static loadings in any direction equal to twice the weight of the container and attachments when filled with LP-Gas, using a safety factor of not less than four, based on the ultimate strength of the material to be used. (*See Chapters 3 and 6 for additional provisions applying to the LP-Gas system used.*)

2-2.5 Containers with Attached Supports.

2-2.5.1 Horizontal containers of more than 2,000 gal (7.6 m^3) water capacity designed for permanent installation in stationary service may be provided with steel saddles designed to permit mounting the containers on flat topped concrete foundations. The total height of the outside bottom of the container shell above the top of the concrete foundation shall not exceed 6 in. (152 mm).

2-2.5.2 Horizontal containers of 2,000 gal (7.6 m^3) water capacity or less, designed for permanent installation in stationary service, may be equipped with nonfireproofed structural steel supports and designed to permit mounting on firm foundations in accordance with 2-2.5.2 (a) or (b).

(a) For installation on paved surfaces or concrete pads within 4 in. (102 mm) of ground level, the structural steel supports shall be designed so that the bottoms of the horizontal members are not less than 2 in. (51 mm), nor more than 12 in. (305 mm) below the outside bottom of the container shell.

(b) For installation on concrete pads at the ground level, or not to exceed 2 in. (51 mm) above the ground level, the structural steel supports may be designed so that the bottoms of the structural members are not more than 24 in. (610 mm) below the outside bottom of the container shell. [*See 3-2.3.2(a)(3) for installation provisions for such containers which are customarily used as components of prefabricated container-pump assemblies.*]

2-2.5.3 Vertical ASME containers over 2,000 gal (7.6 m^3) water capacity designed for permanent installation in stationary service shall be designed with steel supports designed to permit mounting the container on, and fastening it to, concrete foundations or supports. Such steel supports shall be designed to make the container self-supporting without guy wires and shall satisfy proper design criteria, taking into account wind, seismic (earthquake) forces, and hydrostatic test load criteria established in 2-2.2.3.

(a) The steel supports shall be protected against fire exposure with a metal having a fire resistance rating of at least two hours. Continuous steel skirts having only one opening 18 in. (256 m) or less in diameter need such fire protection applied only to the outside of the skirt.

2-2.5.4 Containers to be used as portable storage containers (*see definition*) for temporary stationay service (normally less than 12 months at any given location) and to be moved only when substantially empty of liquid shall comply with 2-2.5.4(a) and (b).

(a) If mounted on legs or supports, such supports shall be of steel, and shall either be welded to the container by the manufacturer at the time of fabrication or shall be attached to lugs which have been so welded to the container. The legs or supports or the lugs for the attachment of these legs or supports shall be secured to the container in accordance with the code or rule under which the container is designed and built, with a minimum factor of safety of four, to withstand loading in any direction equal to twice the weight of the empty container and attachments.

(b) If the container is mounted on a trailer or semitrailer running gear so that the unit can be moved by a conventional over-the-road tractor, attachment to the vehicle, or attachments to the container to make it a vehicle, shall comply with the appropriate DOT requirements for cargo tank service; except that stress calculations shall be based on twice the weight of the empty container. The unit shall also comply with applicable State and DOT motor carrier regulations and shall be approved by the authority having jurisdiction.

2-2.5.5 Portable tanks (*see definition*) shall comply with DOT portable tank container specifications as to container design and construction, securing of skids or lugs for the attachment of skids and protection of fittings. In addition, the bottom of the skids shall be not less than 2 in. (51 mm) or more than 12 in. (305 mm) below the outside bottom of the container shell.

2-2.6 Container Markings.

2-2.6.1 Containers shall be marked as provided in the Regulations, Rules or Code under which they are fabricated and in accordance with 2-2.6.2 through 2-2.6.5 as applicable.

2-2.6.2 When LP-Gas and one or more other compressed gases are to be stored or used in the same area, the containers shall be be marked "Flammable" and either "LP-Gas," "LPG," "Propane" or "Butane." Compliance with marking requirements of Title 49 of the *Code of Federal Regulations* shall meet this provision.

2-2.6.3 When being transported, portable DOT containers shall be marked and labeled in accordance with Title 49 of the *Code of Federal Regulations*.

2-2.6.4 Portable DOT containers designed to be filled by weight, including those optionally filled volumetrically but which may require check weighing, shall be marked with:

(a) The water capacity of the container in lb.

(b) The tare weight of the container in lb, fitted for service. The tare weight is the container weight plus the weight of all permanently attached valves and other fittings, but does not include the weight of protecting devices removed in order to load the container.

2-2.6.5 ASME containers shall be marked in accordance with 2-2.6.5(a) through (l). The markings specified shall be on a metal nameplate attached to the container, so located as to remain visible after the container is installed. The nameplate shall be attached in such a way that corrosion of either the nameplate or the container will be minimized.

(a) Service for which the container is designed; i.e. underground, aboveground, or both.

(b) Name and address of container supplier or trade name of container.

(c) Water capacity of container in lb or US Gallons.

(d) Design pressure in psig.

(e) The wording "This container shall not contain a product having a vapor pressure in excess of ____ psig at 100°F." (*See Table 2-2.2.2.*)

(f) Tare weight of container fitted for service for containers to be filled by weight.

(g) Outside surface area in sq ft.

(h) Year of manufacture.

(i) Shell thickness _____ head thickness.

(j) OL _____ OD _____ HD _____.

(k) Manufacturer's Serial Number.

(l) ASME Code Symbol.

2-3 Container Appurtenances.

2-3.1 General.

2-3.1.1 This section includes fabrication and performance provisions for container appurtenances, such as pressure relief devices, container shutoff valves, back-flow check valves, internal valves, excess-flow check valves, plugs, liquid level gauges and pressure gauges connected directly into the container openings described in 2-2.3. Shop installation of such appurtenances in containers listed as container assemblies or container systems in accordance with 1-3.1.1 is a responsibility of the fabricator under the listing. Field installation of such appurtenances is covered in Chapter 3.

2-3.1.2 Container appurtenances shall be fabricated of materials suitable for LP-Gas service and resistant to the action of LP-Gas under service conditions. Cast iron shall not be used. Cast malleable or ductile iron is not considered as cast iron in this standard. The following also shall apply:

(a) Pressure containing metal parts of appurtenances, such as those listed in 2-3.1.1, except fusible elements, shall have a minimum melting point of 1500°F (816°C) such as steel, ductile (nodular) iron, malleable iron or brass. Ductile iron shall meet the requirements of ASTM A395 or equivalent and malleable iron the requirements of ASTM A47 or equivalent. Approved or listed liquid level gauges used in containers of 3500 gal (13.2 m^3) w.c. or less are exempted from this provision.

2-3.1.3 Container appurtenances shall have a rated working pressure of at least 250 psig (1.7 MPa gauge).

2-3.1.4 Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas. They shall be made of metal or other suitable material confined in metal having a melting point over 1500°F (816°C) or shall be protected against fire exposure, except that aluminum O-rings and spiral wound metal gaskets are acceptable and gaskets for use with approved or listed liquid level gauges for installation on a container of 3500 gal (13.2 m^3) w.c. or less are exempted from this provision. When a flange is opened, the gasket shall be replaced.

2-3.2 Pressure Relief Devices. (*See 2-4.7 for hydrostatic relief valves.*)

2-3.2.1 Containers shall be equipped with one or more pressure relief devices which, except as otherwise provided for in 2-3.2.2, shall be designed to relieve vapor.

2-3.2.2 DOT containers shall be equipped with pressure relief valves or fusible plug devices as required by DOT Regulations. (*See Appendix D for additional information.*)

2-3.2.3 ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with applicable requirements of the *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, UL 132; Standards for Safety Relief Valves of the Factory Mutual Research Corporation; or other equivalent pressure relief valve standards. The start-to-leak setting of such pressure relief valves, with relation to the design pressure of the container, shall be in accordance with Table 2-3.2.3.

Exception: On containers of 40,000 gal (151 m³) water capacity or more, a pilot operated pressure relief valve in which the relief device is combined with and is controlled by a self-actuated, direct, spring-loaded pilot valve may be used provided it complies with Table 2-3.2.3, is approved (see definition), is inspected and maintained by persons with appropriate training and experience and is tested for proper operation at intervals not exceeding 5 years.

Table 2-3.2.3

Containers	Minimum	Maximum
All ASME Codes prior to the 1949 Edition, and the 1949 Edition, paragraphs U-68 and U-69	110%	125%*
ASME Code, 1949 Edition, Paragraphs U-200 and U-201, and all ASME Codes later than 1949	100%	100%*

*Manufacturers of pressure relief valves are allowed a plus tolerance not exceeding 10 percent of the set pressure marked on the valve.

2-3.2.4 Pressure relief valves for ASME containers shall also comply with 2-3.2.4(a) through (e).

(a) Pressure relief valves shall be of sufficient individual or aggregate capacity as to provide the relieving capacity in accordance with Appendix D for the container on which they are installed, and to relieve at not less than the rate indicated before the pressure is in excess of 120 percent of the maximum (not including the 10 percent referred to in the Note of Table 2-3.2.3) permitted start-to-leak pressure setting of the device. This provision is applicable to all containers (including containers installed partially aboveground) except containers installed wholly underground in accordance with D-2.3.1.

(b) Each pressure relief valve shall be plainly and permanently marked with: (1) the pressure in psig at which the valve is set to start-to-leak; (2) rated relieving capacity in cu ft per minute of air at 60°F (15.6°C) and 14.7 psia (0.1 MPa absolute); and (3) the manufacturer's name and catalog number. Example : A pressure relief valve is marked 250-4050 AIR. This indicates that the valve is set to start-to-leak at 250 psig (1.7 MPa gauge); and that its rated relieving capacity is 4050 cfm (1.9 m^3/s) of air.

(c) Shutoff valves shall not be located between a pressure relief device and the container, unless the arrangement is such that the relief device relieving capacity flow specified in 2-3.2.4(a) will be achieved through additional pressure relief devices which remain operative.

(d) Pressure relief valves shall be so designed that the possibility of tampering will be minimized. Externally set or adjusted valves shall be provided with an approved means of sealing the adjustment.

(e) Fusible plug devices, with a yield point of 208°F (98°C) minimum and 220°F (104°C) maximum, with a total discharge area not exceeding 0.25 sq in. (1.6 cm^2), and which communicate directly with the vapor space of the container, may be used in addition to the spring-loaded pressure relief valves (as specified in Table 2-3.2.3) for aboveground containers of 1,200 gal (4.5 m^3) water capacity or less.

2-3.2.5 All containers used in industrial truck (including fork lift truck cylinders) service shall have the container pressure relief valve replaced by a new or unused valve within 12 years of the date of manufacture of the container and each 10 years thereafter.

2-3.3 Connections for Flow Control (Filling, Withdrawal Equalizing).

2-3.3.1 Shutoff valves, excess-flow check valves, back-flow check valves and quick closing internal valves, used individually or in suitable combinations, at container filling, withdrawal and equalizing connections, shall comply with 2-3.1.2 and 2-3.1.3.

2-3.3.2 Filling, withdrawal and equalizing connections shall be equipped with the appurtenances for the appropriate type and capacity of container and the service in which they are to be used in accordance with Table 2-3.3.2. Cylinder valve outlet connections on all DOT cylinders except those used for engine fuel, from which vapor can be withdrawn, shall not be interchangeable with those used for liquid withdrawal.

(a) If the loading or transfer point is not on the container, it shall be equipped as specified for filling connections on the container.

Table 2-3.3.2 Filling Withdrawal and Equalizing Connections

Type of Use		General Uses												Used as Fuel on Vehicles			Portable Tanks			Cargo Tanks		
Type of Container		DOT Cylinder Specifications									ASME			DOT or ASME			ASME			ASME		
Water Capacity of Containers	Pounds (kg)	1 (0.5) to 1,000 (454)			50 (23) to 1,000 (454)			2.5 (1) to 245 (110)			—			Any			Any			Any		
	Gallons (m³)	—			—			—			Up to 120,000 (454 m³)			Any			Any			Any		
Conditions under which Container is Used		Replacement or Exchange Outdoors			Filled at Point of Use Outdoors			When Used Inside Buildings			Filled at Point of Use Outdoors			Replacement or Fixed			Transportation of LP-Gas			Transportation of LP-Gas		
Connection Use (Note 1): "F" — Filling, "W" — Withdrawal, "E" — Equalizing		F	W	E	F	W	E	F	W	E	F	W	E	F	W	E	F	W	E	F	W	E
Appurtenances to be provided (Note 2):																						
1. Positive (Manual) Shutoff Valve		✓ 3*	✓ 3*	✓	5*	5*						✓ 6*										
2. Positive (Manual) Shutoff & Internal Excess Flow Check Valve				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓ 8*	✓	✓	✓	✓	✓	✓		✓
3. Positive (Manual) Shutoff & External Excess Flow Check Valve (Note 4)					✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓
4. Single Back Flow Check Valve					✓																	
5. Positive (Manual) Shutoff & Internal Back Flow Check Valve											✓			✓			✓			✓		
6. Excess Flow Check Valve & Back Flow Check Valve				✓	✓		✓				✓		✓			✓	✓		✓	✓		✓
7. Double Back Flow Check Valve					✓						✓			✓			✓			✓		
8. Quick Closing Internal Valve											✓	✓	✓				✓	✓	✓	✓	✓ 7*	✓
Column Number		1			2			3			4			5			6			7		

* Note Number.

Notes to Table 2-3.3.2

Note 1: Containers are not required to be equipped with all three connections, but if used, appurtenances shall be those shown. Suitably fitted multipurpose valves may be used.

Note 2: If more than one appurtenance, or combination of appurtenances, is shown for any connection use, any one of the appurtenances or combinations shown will comply. (*See also DOT regulations for cargo and portable containers.*)

Note 3: Single manual shutoff valve normally used for both filling and withdrawal.

Note 4: External excess-flow check valves shall be installed in such a way that any undue strain beyond them will not cause breakage between the container and the excess-flow check valves.

Note 5: Containers of less than 50 lb (23 kg) water capacity need only be equipped with a positive shutoff valve for filling at the point of use.

Note 6: An excess flow check valve is not required in the withdrawal connection provided the following are all complied with:

(a) Container water capacity does not exceed 2,000 gal (7.6 m^3).

(b) Withdrawal outlet is equipped with a manually operable (having a handwheel or the equivalent) shutoff valve, which is:

(1) threaded directly into the container outlet, or

(2) an integral part of a substantial fitting which is threaded directly into or on the container outlet, or

(3) threaded directly into a substantial fitting which is threaded directly into or on the container outlet.

(c) The controlling orifice between the container contents and the shutoff valve outlet does not exceed 5/16 in. (8 mm) in diameter for vapor withdrawal or 1/8 in. (3 mm) for liquid withdrawal.

(d) An approved pressure-reducing regulator is directly attached to the outlet of the shutoff valve and is rigidly supported, or is adequately supported and properly protected on or at the container, and is connected to the shutoff valve by means of a suitable flexible connection.

Note 7: See 6-3.2.1(a) for special requirements for containers constructed to DOT cargo tank specifications.

Note 8: Authorized for exchangeable (removable) containers only.

2-3.3.3 The appurtenances specified in Table 2-3.3.2 shall comply with 2-3.3.3(a) through 2-3.3.3(d).

(a) Manual shutoff valves shall be designed to provide positive closure under service conditions.

(b) Excess-flow check valves shall be designed to close automatically at the rated flows of vapor or liquid specified by the manufacturer. Excess flow valves shall be designed with a bypass, not to exceed a No. 60 drill size opening, to allow equalization of pressure.

(c) Back-flow check valves, which may be of spring-loaded or weight-loaded type with in-line or swing operation, shall close when flow is either stopped or reversed. Both valves of double back-flow check valves shall comply with this provision.

(d) Internal valves (*see definition*), either manually or automatically operated and designed to remain closed except during operating periods, shall be considered positive shutoff valves. [*See 6-3.2.1(a) for special requirements for such valves used on cargo units.*]

2-3.3.4 The appurtenances specified in Table 2-3.3.2 may be installed as individual components or as combinations completely assembled by the appurtenance manufacturer.

2-3.4 Liquid Level Gauging Devices.

2-3.4.1 Liquid level gauging devices shall be provided on all containers filled by volume. Fixed level gauges or variable gauges of the slip tube, rotary tube or float types (or combinations of such gauges) may be used to comply with this provision.

2-3.4.2 Every container constructed after December 31, 1965, designed to be filled on a volumetric basis, shall be equipped with a fixed liquid level gauge(s) to indicate the maximum filling level(s) for the service(s) in which the container is to be used (*see 4-5.3.3*). This may be accomplished either by using a dip tube of appropriate length, or by the position of the gauging device in the container. The following shall apply:

(a) ASME containers manufactured after December 31, 1969, shall have permanently attached to the container adjacent to the fixed liquid level gauge, or on the container nameplate, markings showing the percentage full that is indicated by that gauge.

(b) Containers constructed to DOT cylinder specifications shall have stamped on the container the letters "DT" followed by the vertical distance (to the nearest tenth inch) from the top of the boss or coupling into which the gauge, or the container valve of which it is a part, is made up, to the end of the dip tube. [*See 2-3.4.2(c)(2) for DOT containers designed for loading in either the vertical or horizontal position.*]

(c) Each container manufactured after December 31, 1972, equipped with a fixed liquid level gauge for which the tube is not welded in place shall be permanently marked adjacent to such gauge or on container nameplate as follows:

(1) Containers designed to be filled in one position shall be marked with the letters "DT" followed by the vertical distance (to the nearest tenth inch) measured from the top center of the container boss or coupling into which the gauge is installed to the maximum permitted filling level.

(2) Portable universal type containers that may be filled in either vertical or horizontal position shall be marked as follows:

a. For Vertical Filling: With the letters "VDT" followed by the vertical distance (to the nearest tenth inch), measured from the top center of the container boss or coupling into which the gauge is installed to the maximum permitted filling level.

b. For Horizontal Filling: With the letters "HDT" followed by the vertical distance (to the nearest tenth inch), measured from the top centerline of the container boss or coupling opening into which the gauge is installed to the inside top of the container when in the horizontal position.

(d) Cargo tanks having several fixed level gauges positioned at different levels shall have stamped adjacent to each gauge the loading percentage (to the nearest $\frac{2}{10}$ percent) of the container content which that particular gauge indicates.

2-3.4.3 The intent of 2-3.4.2 may be achieved by other methods acceptable to the authority having jurisdiction.

2-3.4.4 Variable liquid level gauges shall comply with 2-3.4.4(a) through (e).

(a) Variable liquid level gauges shall be so marked that the maximum liquid level, in in. or percent of capacity of the container in which they are to be installed, is readily determinable. These markings shall indicate the maximum liquid level for propane, for 50/50 butane-propane mixtures, and for butane at liquid temperatures from 20°F (-6.7°C) to 130°F (54.4°C) and in increments not greater than 20 Fahrenheit degrees.

(b) The markings indicating the various liquid levels from empty to full shall either be directly on the system nameplate or on the gauging device or on both.

(c) Dials of magnetic float or rotary gauges shall show whether they are for cylindrical or spherical containers, and whether for aboveground or underground service.

(d) The dials of gauges for use only on aboveground containers of over 1,200 gal (4.5 m^3) water capacity shall be so marked.

(e) Variable liquid level gauges shall comply with the accuracy provisions of 4-5.3.3(b) if they are used for filling containers.

2-3.4.5 Gauging devices requiring bleeding of product to the atmosphere, such as fixed liquid level, rotary tube, and slip tube gauges, shall be designed so that the bleed valve maximum opening to the atmosphere is not larger than a No. 54 drill size, unless equipped with excess-flow check valves.

2-3.5 Pressure Gauges.

2-3.5.1 Pressure gauges shall comply with 2-3.1.2 and 2-3.1.3.

2-3.5.2 Pressure gauges shall be attached directly to the container opening or to a valve or fitting which is directly attached to the container opening. If the effective opening into the container will permit a flow greater than that of a No. 54 drill size, an excess-flow check valve shall be provided.

2-3.6 Other Container Connections.

2-3.6.1 Container openings, other than those equipped as provided in 2-2.2, 2-2.3, 2-2.4, and 2-2.5, shall be equipped with one of the following:

(a) A positive shutoff valve in combination with an excess-flow valve.

(b) A combination of an internal excess-flow valve and a plug.

(c) A plug.

2-4 Piping (Including Hose), Fittings and Valves.

2-4.1 General.

2-4.1.1 This section includes basic design provisions and material specifications for pipe, tubing, pipe and tubing fittings, valves (including hydrostatic relief valves), hose, hose connections and flexible connectors used to connect container appurtenances with the balance of the LP-Gas system in accordance with the installation provisions of Chapter 3.

2-4.1.2 Piping, pipe and tubing fittings and valves used to supply utilization equipment within the scope of NFPA 54, *National Fuel Gas Code*, shall comply with that Code.

2-4.1.3 Pipe and tubing shall comply with 2-4.2.1 and 2-4.3.1 or shall be of material which has been investigated and tested to determine that it is safe and suitable for the proposed service and is recommended for that service by the manufacturer, and be acceptable to the authority having jurisdiction.

2-4.2 Pipe.

2-4.2.1 Pipe shall be wrought iron or steel (black or galvanized), brass, copper, or polyethylene (*see 3-2.7.6*) and shall comply with 2-4.2.1(a) through (g).

(a) Wrought iron pipe; ANSI B36.10, *Welded and Seamless Wrought Steel Pipe*.

(b) Steel Pipe; *Welded and Seamless Steel Pipe* (ANSI/ASTM A53).

(c) Steel pipe; *Seamless Carbon Steel Pipe for High Temperature Service* (ANSI/ASTM A106a).

(d) Steel pipe; *Black and Hot Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses* (ANSI/ASTM A120).

(e) Brass Pipe; *Seamless Red Brass Pipe* (ANSI/ASTM B43).

(f) Copper Pipe; *Seamless Copper Pipe* (ANSI/ASTM B42).

(g) Polyethylene Pipe; *Thermoplastic Gas Pressure Pipe, Tubing and Fittings* (ANSI/ASTM D-2513) and be listed or approved.

2-4.3 Tubing.

2-4.3.1 Tubing shall be steel, brass, copper, or polyethylene (*see 3-2.7.6*) and shall comply with 2-4.3.1(a) through (d):

(a) Steel tubing; *Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines* (ANSI/ASTM A539).

(b) Brass tubing [*see 3-2.6.1(d)(3)*]; *Seamless Brass Tube* (ANSI/ASTM B135).

(c) Copper tubing [see 3-2.6.1(d)(3)]:

(1) Type K or L, *Seamless Copper Water Tube*, (ANSI/ASTM B88).

(2) *Seamless Copper Tube for Air Conditioning and Refrigeration Field Service* (ANSI/ASTM B280).

(d) Polyethylene tubing; *Thermoplastic Gas Pressure Pipe, Tubing and Fittings* (ASTM D-2513) and be listed or approved.

2-4.4 Pipe and Tubing Fittings.

2-4.4.1 Fittings shall be steel, brass, copper, malleable iron, ductile (nodular) iron or polyethylene, and shall comply with 2-4.4.1(a) through (c). Cast iron pipe fittings (ells, tees, crosses, couplings, unions, flanges or plugs) shall not be used.

(a) Pipe joints in wrought iron, steel, brass or copper pipe may be screwed, welded or brazed.

(1) Fittings used at pressures higher than container pressure, such as on the discharge of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psig (2.4 MPa gauge).

(2) Except as provided in 2-4.4.1(a)(1), fittings used with liquid LP-Gas, or with vapor LP-Gas at operating pressures over 125 psig (0.9 MPa gauge), shall be suitable for a working pressure of 250 psig (1.7 MPa gauge).

(3) Fittings for use with vapor LP-Gas at pressures not exceeding 125 psig (0.9 MPa gauge) shall be suitable for a working pressure of 125 psig (0.9 MPa gauge).

(4) Soldering or brazing filler material shall have a melting point exceeding 1,000°F (538°C).

(b) Tubing joints in steel, brass or copper tubing shall be flared, soldered or brazed or made up with approved gas tubing fittings.

(1) Fittings used at pressures higher than container pressure, such as on the discharge of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psig (2.4 MPa gauge).

(2) Except as provided in 2-4.4.1(b)(1), fittings used with liquid LP-Gas, or with vapor LP-Gas at operating pressures over 125 psig (0.9 MPa gauge), shall be suitable for a working pressure of 250 psig (1.7 MPa gauge).

(3) Fittings for use with vapor LP-Gas at pressures not exceeding 125 psig (0.9 MPa gauge) shall be suitable for a working pressure of 125 psig (0.9 MPa gauge).

(4) Soldering or brazing filler material shall have a melting point exceeding 1,000°F (538°C).

(c) Joints in polyethylene pipe and tubing shall be made by heat fusion in accordance with the manufacturers' instructions.

(1) Polyethylene fittings shall conform to ANSI/ASTM D-2683, *Socket Type Polyethylene Fittings for Outside Diameter — Controlled Polyethylene Pipe*, or ASTM D-3261, *Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*, and be listed or approved.

2-4.5 Valves, Other than Container Valves.

2-4.5.1 Pressure containing metal parts of valves (except appliance valves), including manual positive shutoff valves, excess-flow check valves, backflow check valves, emergency shutoff valves (*see 2-4.5.4*), and remotely controlled valves (either manually or automatically operated), used in piping systems shall be of steel, ductile (nodular) iron, malleable iron or brass. Ductile iron shall meet the requirements of ANSI/ASTM A395 or equivalent and malleable iron the requirements of ANSI/ASTM A47 or equivalent. All materials used, including valve seat discs, packing, seals, and diaphragms shall be resistant to the action of LP-Gas under service conditions.

2-4.5.2 Valves shall be suitable for the appropriate working pressure, as follows:

(a) Valves used at pressures higher than container pressure, such as on the discharge of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psig (2.4 MPa gauge). [400 psig (2.8 MPa gauge) WOG valves comply with this provision.]

(b) Except as provided in 2-4.5.2(a), valves to be used with liquid LP-Gas, or with vapor LP-Gas at pressures in excess of 125 psig (0.9 MPa gauge), but not to exceed 250 psig (1.7 MPa gauge), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(c) Valves (except appliance valves) to be used with vapor LP-Gas at pressures not to exceed 125 psig (0.9 MPa gauge) shall be suitable for a working pressure of at least 125 psig (0.9 MPa gauge).

2-4.5.3 Manual shutoff valves, emergency shutoff valves (*see 2-4.5.4*), excess-flow check valves and backflow check valves used in piping systems shall comply with the provisions for container valves. [*See 2-3.3.3(a), (b) and (c).*]

2-4.5.4 Emergency shutoff valves shall be approved and incorporate all of the following means of closing (*see 3-2.7.9 and 3-3.3.4*):

(a) Automatic shutoff through thermal (fire) actuation. When fusible elements are used they shall have a melting point not exceeding 250°F (121°C).

(b) Manual shutoff from a remote location.

(c) Manual shutoff at the installed location.

2-4.6 Hose, Quick Connectors, Hose Connections and Flexible Connectors.

2-4.6.1 Hose, hose connections and flexible connectors (*see definition*) shall be fabricated of materials resistant to the action of LP-Gas both as liquid and vapor. If wire braid is used for reinforcement it shall be of corrosion resistant material such as stainless steel.

2-4.6.2 Hose and quick connectors shall be approved (*see Section 1-7, Approved*).

2-4.6.3 Hose, hose connections and flexible connectors used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psig (34.5 kPa gauge), and as provided in Section 3-4 regardless of the pressure, shall comply with 2-4.6.3(a) and (b):

(a) Hose shall be designed for a minimum bursting pressure of 1,750 psig (12 MPa gauge) [350 psig (2.4 MPa gauge) working pressure], and shall be marked with "LP-Gas" or "LPG" and with the working pressure in psig at not greater than 10-ft (3-m) intervals.

(b) Hose assemblies, after the application of connections, shall have a design capability of withstanding a pressure of not less than 700 psig (4.8 MPa gauge). If a test is made, such assemblies shall not be leak tested a pressures higher than the working pressure [350 psig (2.4 MPa gauge) minimum] of the hose.

2-4.6.4 Hoses or flexible connectors used to supply LP-Gas to utilization equipment or appliances shall be installed in accordance with the provisions of 3-2.7.8 and 3-2.7.10.

2-4.7 Hydrostatic Relief Valves.

2-4.7.1 Hydrostatic relief valves designed to relieve the hydrostatic pressure which might develop in sections of liquid piping between closed shutoff valves shall have pressure settings not less than 400 psig (2.8 MPa gauge) or more than 500 psig (3.5 MPa gauge) unless installed in systems designed to operate above 350 psig (2.4 MPa gauge). Hydrostatic relief valves for use in systems designed to operate above 350 psig (2.4 MPa gauge) shall have settings not less than 110 percent or more than 125 percent of the system design pressure.

2-5 Equipment.

2-5.1 General.

2-5.1.1 This section includes fabrication and performance provisions for the pressure containing metal parts of LP-Gas equipment such as pumps, compressors, vaporizers, strainers, meters, sight flow glasses and regulators. Containers are not subject to the provisions of this section.

2-5.1.2 Equipment shall be suitable for the appropriate working pressure as follows:

(a) Equipment to be used at pressures higher than container pressure, such as on the discharge of a liquid pump, shall be suitable for a working pressure of at least 350 psig (2.4 MPa gauge). If pressures above 350 psig (2.4 MPa gauge) are necessary, the pump and all equipment under pressure from the pump shall be suitable for the pump discharge pressure.

(b) Equipment to be used with liquid LP-Gas, or vapor LP-Gas at pressures over 125 psig (0.9 MPa gauge) but not to exceed 250 psig (1.7 MPa gauge), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(c) Equipment to be used with vapor LP-Gas at pressures over 20 psig (138 kPa), but not to exceed 125 psig (0.9 MPa gauge), shall be suitable for a working pressure of at least 125 psig (0.9 MPa gauge).

(d) Equipment to be used with vapor LP-Gas at pressures not to exceed 20 psig (138 kPa) shall be suitable for a working pressure adequate for the service in which it is to be used.

2-5.1.3 Equipment shall be fabricated of materials suitable for LP-Gas service and resistant to the action of LP-Gas under service conditions. Pressure containing metal parts shall be of steel, ductile (nodular) iron (ANSI/ASTM A395 or A536 Grade 60-40-18 or 65-45-12), malleable iron (ANSI/ASTM A47), higher strength gray iron (ANSI/ASTM A48, Class 40B), brass or the equivalent. Cast iron shall not be used for strainers or flow indicators which shall comply with provisions for materials for construction of valves. (*See 2-4.5.1.*) Aluminum may be used for approved meters. Aluminum or zinc may be used for approved regulators.

2-5.2 Pumps.

2-5.2.1 Pumps shall be designed for LP-Gas service and may be of rotary, centrifugal, turbine or reciprocating type.

2-5.2.2 The maximum discharge pressure of a liquid pump under normal operating conditions shall be limited to 350 psig (2.4 MPa gauge).

2-5.3 Compressors.

2-5.3.1 Compressors shall be designed for LP-Gas service and may be of the rotary or reciprocating type and shall be equipped with suitable glands or seals to minimize any release of LP-Gas.

2-5.3.2 Means shall be provided to limit the suction pressure to the maximum for which the compressor is designed.

2-5.3.3 Means shall be provided to prevent the entrance of LP-Gas liquid into the compressor suction, either integral with the compressor, or installed externally in the suction piping [*see 3-2.10.2(b)*].

2-5.4 Vaporizers, Tank Heaters, Vaporizing-Burners and Gas-Air Mixers.

2-5.4.1 Vaporizers may be of the indirect type (utilizing steam, hot water or other heating medium), or direct fired. This subsection does not apply to engine fuel vaporizers or to integral vaporizer-burners such as those used with weed burners or tar kettles.

2-5.4.2 Indirect vaporizers shall comply with 2-5.4.2(a) through (e):

(a) Indirect vaporizers with an inside diameter of more than 6 in. (152 mm) shall be constructed in accordance with the applicable provision of the ASME Code for a design pressure of 250 psig (1.7 MPa gauge) and shall be permanently and legibly marked with:

(1) The marking required by the code.

(2) The allowable working pressure and temperature for which designed.

(3) The sum of the outside surface area and the inside heat exchange surface area in sq ft (m^2).

(4) The name or symbol of the manufacturer.

(b) Indirect vaporizers having an inside diameter of 6 in. (152 mm) or less are exempt from the ASME Code and need not be marked. They shall be constructed for a minimum 250 psig (1.7 MPa gauge) design pressure.

(c) Indirect vaporizers shall be provided with a suitable automatic means to prevent liquid passing through the vaporizer to the vapor discharge piping. This means may be integral with the vaporizer, or otherwise provided in the external piping (*see 3-7.2.6*).

(d) Indirect vaporizers, including atmospheric-type vaporizers using heat from the surrounding air or the ground, and of more than one quart (0.9 L) capacity, shall be equipped, at or near the discharge, with a spring-loaded pressure relief valve providing a relieving capacity in accordance with 2-5.4.5. Fusible plug devices shall not be used.

(e) Indirect atmospheric-type vaporizers of less than one quart (0.9 L) capacity need not be equipped with pressure relief valves, but shall be installed in accordance with 3-7.2.9.

2-5.4.3 Direct-fired vaporizers shall comply with 2-5.4.3(a) through (f).

(a) Design and construction shall be in accordance with the applicable requirements of the ASME Code for the working conditions to which the vaporizer will be subjected, and it shall be permanently and legibly marked with:

(1) The markings required by the code.

(2) The outside surface area in sq ft.

(3) The area of the heat exchange surface in sq ft.

(4) The maximum vaporizing capacity in gal per hour.

(5) The rated heat input in Btuh.

(6) The name or symbol of the manufacturer.

(b) Direct-fired vaporizers shall be equipped, at or near the discharge, with a spring-loaded pressure relief valve providing a relieving capacity in accordance with 2-5.4.5. The relief valve shall be located so as not to be subject to temperatures in excess of 140 °F (60 °C). Fusible plug devices shall not be used.

(c) Direct-fired vaporizers shall be provided with suitable automatic means to prevent liquid passing from the vaporizer to its vapor discharge piping.

(d) A means for manually turning off the gas to the main burner and pilot shall be provided.

(e) Direct-fired vaporizers shall be equipped with an automatic safety device to shut off the flow of gas to the main burner if the pilot light is extinguished. If the pilot flow exceeds 2,000 Btuh (2 MJ/h), the safety device shall shut off the flow of gas to the pilot also.

(f) Direct-fired vaporizers shall be equipped with a limit control to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment, and to prevent raising the pressure within the storage container above the pressure shown in the first column of Table 2-2.2.2 corresponding with the design pressure of the container (or its ASME Code equivalent — see Note 1 of Table 2-2.2.2).

2-5.4.4 Waterbath vaporizers shall comply with 2-5.4.4(a) through (j).

(a) The vaporizing chamber, tubing, pipe coils, or other heat exchange surface containing the LP-Gas to be vaporized, hereinafter referred to as "heat exchanger," shall be constructed in accordance with the applicable provisions of the ASME Code for a minimum design pressure of 250 psig (1.7 MPa gauge) and shall be permanently and legibly marked with:

(1) The marking required by the Code.

(2) The allowable working pressure and temperature for which designed.

(3) The sum of the outside surface and the inside heat exchange surface area in sq ft (m^2).

(4) The name or symbol of the manufacturer.

(b) Heat exchangers for waterbath vaporizers having an inside diameter of 6 in. (152 mm) or less are exempt from the ASME Code and need not be marked. They shall be constructed for a 250 psig (1.7 MPa gauge) minimum design pressure.

(c) Heat exchangers for waterbath vaporizers shall be provided with a suitable automatic control to prevent liquid passing through the heat exchanger to the vapor discharge piping. This control shall be integral with the vaporizer.

(d) Heat exchangers for waterbath vaporizers shall be equipped at or near the discharge with a spring loaded pressure relief valve providing a relieving capacity in accordance with 2-5.4.5. Fusible plug devices shall not be used.

(e) Waterbath sections of waterbath vaporizers shall be designed to eliminate a pressure build-up above the design pressure.

(f) The immersion heater which provides heat to the waterbath shall be installed so as not to contact the heat exchanger and may be electric or gas-fired.

(g) A control to limit the temperature of the waterbath shall be provided.

(h) Gas-fired immersion heaters shall be equipped with an automatic safety device to shut off the flow of gas to the main burner and pilot in the event of flame failure.

(i) Gas-fired immersion heaters with an input of 400,000 Btu (422 mJ/h) per hour or more shall be equipped with an electronic flame safeguard and programming to provide for pre-purge prior to ignition, proof of pilot before main burner valve opens, and full shutdown of main gas and pilot upon flame failure.

(j) A means shall be provided to shut off the source of heat in case the level of the heat transfer medium falls below the top of the heat exchanger.

2-5.4.5 The minimum rate of discharge in cubic-feet-of-air-per-minute for pressure relief valves for LP-Gas vaporizers, either of the indirect type or direct fired, shall be determined as follows:

(a) The surface area of that part of the vaporizer shell directly in contact with LP-Gas to obtain the total surface area in sq ft.

(b) Refer to Table D-2.2.2 to obtain the rate of discharge in cu ft of air per minute (Flow Rate CFM Air) for the total surface area in sq ft for the vaporizer computed in accordance with 2-5.4.5(a).

2-5.4.6 Direct gas-fired tank heaters shall be designed exclusively for outdoor aboveground use and so that there is no direct flame impingement upon the container. The provisions of 2-5.4.6(a) through (f) shall also apply.

(a) Tank heaters shall be approved and be permanently and legibly marked with:

(1) The rated input to the burner in Btuh.

(2) The maximum vaporizing capacity in gal per hour.

(3) The name or symbol of the manufacturer.

(b) The heater shall be designed so that it can be readily removed for inspection of the entire container.

(c) The fuel gas supply connection to the tank heater shall originate in the vapor space of the container being heated and shall be provided with a manually operated shutoff valve at the heater.

(d) The heater control system shall be equipped with an automatic safety shutoff valve of the manual-reset type arranged to shut off the flow of gas to both the main and pilot burners if the pilot flame is extinguished.

(e) When installed on a container exceeding 1,000 gal (3.8 m^3) water capacity, the heater control system shall include a valve to automatically shut off the flow of gas to both the main and pilot burners if the container becomes empty of liquid.

(f) Direct gas-fired tank heaters shall be equipped with a limit control to prevent the heater from raising the pressure in the storage container to more than 75 percent of the pressure shown in the first column of Table 2-2.2.2 corresponding with the design pressure of the container (or its ASME Code equivalent-see Note 1 of Table 2-2.2.2).

2-5.4.7 Vaporizing-burners shall be constructed with a minimum design pressure of 250 psig (1.7 MPa gauge) with a factor of safety of five, and shall comply with 2-5.4.7(a) through (h):

(a) The vaporizing-burner, or the appliance in which it is installed, shall be permanently and legibly marked with:

(1) The maximum burner input in Btuh.

(2) The name or symbol of the manufacturer.

(b) Vaporizing coils or jackets shall be made of ferrous metals or high temperature alloys.

(c) The vaporizing section shall be protected by a hydrostatic relief valve, located where it will not be subjected to temperatures in excess of 140°F (60°C), and with a pressure setting such as to protect the components involved but not lower than 250 psig (1.7 MPa gauge). The relief valve discharge shall be directed upward and away from the component parts of the vaporizing burner. Fusible plug devices shall not be used.

(d) A means shall be provided for manually turning off the gas to the main burner and the pilot.

(e) Vaporizing-burners shall be provided with an automatic safety device to shut off the flow of gas to the main burner and pilot in the event the pilot is extinguished.

(f) Dehydrators and dryers utilizing vaporizing-burners shall be equipped with automatic devices both upstream and downstream of the vaporizing section. These devices shall be installed and connected to shut off in the event of excessive temperature, flame failure, and if applicable, insufficient air flow. See NFPA 61B, *Prevention of Fire and Dust Explosions in Grain Elevators and Bulk Grain Handling Facilities*, for ignition and combustion controls applicable to vaporizing-burners associated with grain dryers.

(g) Pressure regulating and control equipment shall be so located or so protected as not to be subject to temperatures above 140°F (60°C), unless it is designed and recommended for use by the manufacturer for a higher pressure.

(h) Pressure regulating and control equipment located downstream of the vaporizing section shall be designed to withstand the maximum discharge temperature of the hot vapor.

2-5.4.8 Gas-air mixers shall comply with 2-5.4.8(a) through (e).

(a) Gas-air mixers shall be designed for the air, vapor, and mixture pressures to which they are subjected. Piping materials shall comply with applicable portions of this standard.

(b) Gas-air mixers shall be designed so as to prevent the formation of a combustible mixture. Gas-air mixers which are capable of producing combustible mixtures shall be equipped with safety interlocks on both the LP-Gas and air supply lines to shut down the system if combustible limits are approached.

(c) In addition to the interlocks provided for in 2-5.4.8(b), a method shall be provided to prevent air from accidentally entering gas distribution lines without LP-Gas being present. Check valves shall be installed in the air and LP-Gas supply lines close to the mixer to minimize the possibility of backflow of gas into the air supply lines or of air into the LP-Gas system. Gas mixing control valves in the LP-Gas and air supply lines which are arranged to fail closed when actuated by safety interlock trip devices shall be considered as acceptable shutdown devices.

(d) Where it is possible for condensation to take place between the vaporizer and the gas-air mixer, an interlock shall be provided to prevent LP-Gas liquid from entering the gas-air mixer.

(e) Gas-air mixers which utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere, and are so designed that maximum air entrained is less than 85 percent of the mixture, need not include the interlocks specified in 2-5.4.8(b), (c), and (d), but shall be equipped with a check valve at the air intake to prevent the escape of gas to atmosphere when shut down. Gas-air mixers of this type receiving air from a blower, compressor, or any source of air other than directly from the atmosphere, shall include a method of preventing air without LP-Gas, or mixtures of air and LP-Gas within the flammable range, from entering the gas distribution system accidentally.

2-5.5 Strainers.

2-5.5.1 Strainers shall be designed to minimize the possibility of particulate materials clogging lines and damaging pumps, compressors, meters or regulators. The strainer element shall be accessible for cleaning.

2-5.6 Meters.

2-5.6.1 Vapor meters of the tin or brass case type of soldered construction shall not be used at pressures in excess of 1 psig (7 kPa gauge).

2-5.6.2 Vapor meters of the die cast or iron case type may be used at any pressure equal to or less than the working pressure for which they are designed and marked.

2-5.7 Dispensing Devices.

2-5.7.1 Components of dispensing devices, such as meters, vapor separators, valves and fittings within the dispenser, shall comply with 2-5.1.2(b) and 2-5.1.3.

2-5.7.2 Pumps of dispensers used to transfer LP-Gas shall comply with 2-5.1.2(b), 2-5.1.3 and with 2-5.2. Such pumps shall be equipped to permit control of the flow and to minimize the possibility of leakage or accidental discharge. Means shall be provided on the outside of the dispenser to readily shut off the power in the event of fire or accident. This means may be integral with the dispenser or provided externally when the dispenser is installed. (*See 3-2.10.6.*)

2-5.7.3 Dispensing hose shall comply with 2-4.6.1 through 2-4.6.3. An excess-flow check valve or an automatic shutoff valve complying with 2-3.3.3(a), (b) and (c) and 2-4.5.3, or 2-3.3.3(d) and 2-4.5.4, shall be installed in or on the dispenser at the point at which the dispenser hose is connected to the liquid piping. A differential back pressure valve shall be considered as meeting these provisions.

2-5.8 Regulators.

2-5.8.1 Final stage regulators (excluding appliance regulators) shall be equipped with one or both of the following: [*See 3-2.5.2(b) for required protection from the elements which may be integral with the regulator.*]

(a) A pressure relief valve on the low pressure side having a start-to-leak pressure setting within limits specified in Table 2-5.8.1

(b) A shutoff device that shuts the gas off at the regulator inlet when the downstream pressure reaches the overpressure limits specified in Table 2-5.8.1. Such a device shall not open to permit flow of gas until it has been manually reset.

Table 2-5.8.1

Regulator Delivery Pressure in psig (kPa gauge)	Relief Valve Start-to-Leak Pressure Setting, % of Regulator Delivery Pressure Minimum	Maximum
1 (7) or less	170%	300%
Above 1 (7), not over 3 (21)	140%	250%
Above 3 (21)	125%	250%

2-5.9 Sight Flow Glasses.

2-5.9.1 Flow indicators, either of the simple observation type or combined with a back-flow check valve, may be used in applications in which the observation of liquid flow through the piping is desirable or necessary.

2-6 Appliances.

2-6.1 General.

2-6.1.1 This section includes basic construction and performance provisions for LP-Gas consuming appliances.

2-6.2 Approved Appliances.

2-6.2.1 New residential, commercial and industrial LP-Gas consuming appliances, except for those covered in 2-6.2.2 and 2-6.3.1, shall be approved.

2-6.2.2 For an appliance, class of appliance, or appliance accessory for which no applicable standard has been developed, approval of the authority having jurisdiction may be required before installation is made.

2-6.3 Provisions for Appliances.

2-6.3.1 Any appliance, originally manufactured for operation with a gaseous fuel other than LP-Gas, and in good condition, may be used with LP-Gas provided it is properly converted, adapted and tested for performance with LP-Gas before being placed into use.

2-6.3.2 Unattended heaters used inside buildings for animal or poultry production or care shall be equipped with approved automatic devices to shut off the flow of gas to the main burners, and pilots if used, in the event of flame extinguishment or combustion failure. (*See 3-5.1.3 for exception to this provision when such heaters are used in buildings without enclosing walls.*)

2-6.3.3 Appliances using vaporizing-burners shall comply with 2-5.4.7.

2-6.3.4 Appliances used in mobile homes and recreational vehicles shall be approved for such service.

2-6.3.5 LP-Gas appliances used on commercial vehicles (*see Section 4-9*) shall be approved for the service (*see 2-6.2*) and shall comply with 2-6.3.5(a) through (c).

(a) Gas-fired heating appliances and water heaters shall be equipped with automatic devices designed to shut off the flow of gas to the main burner and the pilot in the event the pilot flame is extinguished.

(b) Catalytic heating appliances shall be equipped with an approved automatic device to shut off the flow of gas in the event of combustion failure.

(c) Gas-fired heating appliances and water heaters to be used in vehicles intended for human occupancy shall make provisions for complete separation of the combustion system and the living space. If this separation is not integral with the appliance, it shall be provided otherwise by the method of installation (*see 3-9.4.2*).

Chapter 3 Installation of LP-Gas Systems

3-1 Scope.

3-1.1 Application.

3-1.1.1 This chapter applies to the field installation of LP-Gas systems utilizing components, subassemblies, container assemblies and container systems fabricated in accordance with Chapter 2.

3-1.1.2 Section 3-2 includes general provisions applicable to most stationary systems. Sections 3-3 to 3-9 extend and modify Section 3-2 for systems installed for specific purposes.

3-1.1.3 Installation of systems used in the highway transportation of LP-Gas is covered in Chapter 6.

3-1.1.4 LP-Gas systems shall be installed in accordance with this standard and other national standards or regulations which may apply. These include:

(a) NFPA 54, *National Fuel Gas Code* (ANSI 223.1).

(b) NFPA 37, *Stationary Combustion Engines and Gas Turbines*.

(c) NFPA 501A, *Firesafety Criteria for Mobile Home Installations, Sites and Communities*.

(d) NFPA 501C, *Firesafety Criteria for Recreational Vehicles*.

(e) NFPA 96, *Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment*.

(f) NFPA 86A, *Ovens and Furnaces*.

(g) NFPA 82, *Incinerators, Waste and Linen Handling Systems and Equipment*.

(h) NFPA 302, *Motor Craft (Pleasure and Commercial)*.

(i) NFPA 61B, *Grain Elevators and Bulk Handling Facilities (Grain Dryers)*.

(j) US DOT Regulations, 49 CFR 191 and 192, for LP-Gas pipeline systems subject to DOT.

3-2 General Provisions.

3-2.1 Application.

3-2.1.1 This section includes location and installation criteria for containers; the installation of container appurtenances and regulators; piping service limitations; the installation of piping (including flexible connectors and hose); hydrostatic relief valves and equipment (other than vaporizers, see Section 3-7); and the testing of piping systems.

3-2.1.2 The provisions of this section are subject to modification for systems used for certain specific purposes (*see 3-1.1.2*).

3-2.1.3 For container appurtenances and gaskets installed on containers in excess of 3500 gal (13 m³) w.c., see 2-3.1.2(a) and 2-3.1.4.

3-2.2 Location of Containers.

3-2.2.1 LP-Gas containers shall be located outside of buildings, except as follows:

(a) Portable containers as specifically provided for in Section 3-4.

(b) Containers of less than 125 gal (0.5 m³) water capacity for the purposes of being filled in buildings or structures complying with Chapter 7.

(c) Containers on LP-Gas vehicles complying with, and parked or garaged in accordance with, Chapter 6.

(d) Containers used with LP-Gas stationary or portable engine fuel systems complying with Section 3-6.

(e) Containers used with LP-Gas fueled industrial trucks complying with 3-6.3.6.

(f) Containers on LP-Gas fueled vehicles garaged in accordance with 3-6.6.

(g) Portable containers awaiting use or resale when stored in accordance with Chapter 5.

3-2.2.2 Containers installed outside of buildings, whether of the portable type replaced on a cylinder exchange basis, or permanently installed and refilled at the installation, shall be located with respect to the nearest container, important building, group of buildings, or line of adjoining property which may be built upon, in accordance with Table 3-2.2.2 or with 3-2.2.3.

3-2.2.3 Where storage containers having an aggregate water capacity of more than 4,000 gal (15 m³) are located in heavily populated or congested areas, the siting provisions of 3-2.2.2 and Table 3-2.2.2 may be modified as indicated by the fire safety analysis described in 3-10.2.3.

Table 3-2.2.2

	Minimum Distances		
Water Capacity Per Container Gallons (m^3)	Mounded or Underground Containers [Note (d)]	Aboveground Containers	Between Containers [Note (e)]
Less than 125 (0.5)	10 ft (3 m)	None	None
[Note (a)]		[Note (b)]	
125 to 250 (0.5 to 1.0)	10 ft (3 m)	10 ft (3 m)	None
251 to 500 (1.0 + to 1.9)	10 ft (3 m)	10 ft (3 m)	3 ft (1 m)
501 to 2,000 (1.9 + to 7.6)	10 ft (3 m)	25 ft (7.6 m) [Note (c)]	3 ft (1 m)
2,001 to 30,000 (7.6 + to 114)	50 ft (15 m)	50 ft (15 m)	5 ft (1.5 m)
30,001 to 70,000 (114 + to 265)	50 ft (15 m)	75 ft (23 m)	(¼ of sum of diameters of adjacent containers)
70,001 to 90,000 (265 + to 341)	50 ft (15 m)	100 ft (30 m)	
90,001 to 120,000 (341 + to 454)	50 ft (15 m)	125 ft (38 m)	

Notes to Table 3-2.2.2

Note (a) At a consumer site, if the aggregate water capacity of a multi-container installation comprised of individual containers having a water capacity of less than 125 gal (0.5 m^3) is 501 gal (1.9 + m^3) or more, the minimum distance shall comply with the appropriate portion of this table, applying the aggregate capacity rather than the capacity per container. If more than one such installation is made, each installation shall be separated from any other installation by at least 25 ft (7.6 m). Do not apply the MINIMUM DISTANCES BETWEEN CONTAINERS to such installations.

Note (b) The following shall apply to aboveground containers installed alongside of buildings:

(1) DOT specification containers shall be located and installed so that the discharge from the container pressure relief device is at least 3 ft (1 m) horizontally away from any building opening below the level of such discharge, and shall not be beneath any building unless this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter. The discharge from container pressure relief devices shall be located not less than 5 ft (1.5 m) in any direction away from any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

(2) ASME containers of less than 125 gal (0.5 m^3) water capacity shall be located and installed so that the discharge from pressure relief devices shall not terminate in or beneath any building and shall be located at least 5 ft (1.5 m) horizontally away from any building opening below the level of such discharge, and not less than 5 ft (1.5 m) in any direction away from any exterior source of ignition, openings into direct vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

(3) The filling connection and the vent from liquid level gauges on either DOT or ASME containers filled at the point of installation shall be not less than 10 ft (3 m) in any direction away from any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances, or mechanical ventilation air intakes.

Note (c) This distance may be reduced to not less than 10 ft (3 m) for a single container of 1,200 gal (4.5 m^3) water capacity or less provided such container is at least 25 ft (7.6 m) from any other LP-Gas container of more than 125 gal (0.5 m^3) water capacity.

Note (d) Minimum distances for underground containers shall be measured from the pressure relief device and filling or liquid level gauge vent connection at the container, except that no part of an underground container shall be less than 10 ft (3 m) from a building or line of adjoining property which may be built upon.

Note (e) When underground multi-container installations are made of individual containers having a water capacity of 125 gal (0.5 m³) or more, such containers shall be installed so as to permit access at their ends or sides to facilitate working with cranes or hoists.

3-2.2.4 In the case of buildings of other than wood-frame construction devoted exclusively to gas manufacturing and distribution operations, including LP-Gas service stations, the above distances may be reduced provided that in no case shall containers having a water capacity exceeding 500 gal (1.9 m³) be located closer than 10 ft (3 m) to such gas manufacturing and distributing buildings.

3-2.2.5 The following provisions shall also apply:

(a) Containers shall not be stacked one above the other.

(b) Loose or piled combustible material and weeds and long dry grass shall not be permitted within 10 ft (3 m) of any container.

(c) Suitable means shall be used to prevent the accumulation or flow of liquids having flash points below 200°F (93.4°C) under adjacent LP-Gas containers such as by dikes, diversion curbs or grading. Determination of flash points shall be in accordance with NFPA 321, *Standard on Basic Classification of Flammable and Combustible Liquids*.

(d) When tanks containing flammable or combustible liquids (*see NFPA 321 for definitions of these liquids*) are within a diked area, LP-Gas containers shall be outside the diked area and at least 10 ft (3 m) away from the centerline of the wall of the diked area.

(e) The minimum horizontal separation between aboveground LP-Gas containers and aboveground tanks containing liquids having flash points below 200°F (93.4°C) shall be 20 ft (6 m). This provision shall not apply when LP-Gas containers of 125 gal (0.5 m³) or less water capacity are installed adjacent to fuel oil supply tanks of 660 gal (2.5 m³) or less capacity. No horizontal separation is required between aboveground LP-Gas containers and underground tanks containing flammable or combustible liquids installed in accordance with NFPA 30, *Flammable and Combustible Liquids Code*. See 3-2.2.5(c) for flash point determinations.

(f) The minimum separation between LP-Gas containers and oxygen or gaseous hydrogen containers shall be in accordance with Table 3-2.2.5(f) except that lesser distances are permitted where protective structures having a minimum fire resistance rating of two hours interrupt the line of sight between uninsulated portions of the oxygen or hydrogen containers and the LP-Gas containers. The location and arrangement of such structures shall minimize the problems cited in the Note to 3-2.2.7. Also, see NFPA 50 and 51 for oxygen systems and NFPA 50A on gaseous hydrogen systems. The minimum separation between LP-Gas containers and liquefied hydrogen containers shall be in accordance with NFPA 50B.

Table 3-2.2.5(f)

LP-Gas Containers Having An	Separation From Oxygen Containers Having An			Separation From Gaseous Hydrogen Containers Having An		
Aggregate Water Capacity of	Aggregate capacity of 400 CF (11 m^3)* or less	Aggregate capacity of more than 400 CF (11 m^3)* to 20,000 CF (566 m^3),* including unconnected reserves.	Aggregate capacity of more than 20,000 CF (566 m^3),* including unconnected reserves.	Aggregate capacity of less than 400 CF (11 m^3)*	Aggregate capacity of 400 CF (11 m^3)* to 3000 CF (85 m^3)*	Aggregate capacity of more than 3000 CF (85 m^3)*
1200 Gal (4.5 m^3) or less	None	20 ft (6 m)	25 ft (7.6 m)			
Over 1200 Gal (4.5 m^3)	None	20 ft (6 m)	50 ft (15 m)			
500 Gal (1.9 m^3) or less				None	10 ft (3 m)	25 ft (7.6 m)
Over 500 Gal (1.9 m^3)				None	25 ft (7.6 m)	50 ft (15 m)

*Cubic feet measured at 70°F and atmospheric pressure.

(g) Where necessary to prevent flotation due to possible high flood waters around aboveground containers, or high water table for those underground, containers shall be securely anchored.

(h) When LP-Gas containers are to be stored or used in the same area with other compressed gases, the containers shall be marked to identify their content in accordance with ANSI Standard Z48.1, *Method of Marking Portable Compressed Gas Containers to Identify the Material Contained*.

3-2.2.6 Because of the pronounced volatility of LP-Gas in installations covered by this standard, dikes normally serve no useful purpose. [*See 3-2.2.5(c).*]

3-2.2.7 Except as permitted by 3-2.2.2, 3-2.2.5(c), 3-2.2.5(f) and 3-3.6.1, structures such as fire walls, fences, earth or concrete barriers and other similar structures shall be avoided around or over installed containers.

Exception: Such structures paritally enclosing containers are permissible if designed in accordance with a sound fire protection analysis.

NOTE: The presence of such structures can create significant hazards, e.g., pocketing of escaping gas, interference with application of cooling water by fire departments, redirection of flames against containers and impeding egress of personnel in an emergency.

3-2.3 Installation of Containers.

3-2.3.1 Containers shall be installed in accordance with 3-2.3.1(a) through (f):

(a) DOT cylinder specification containers shall be installed only aboveground, and shall be set upon a firm foundation, or otherwise firmly secured. Flexibility shall be provided in the connecting piping. (*See 3-2.7.5 and 3-2.7.8.*)

(b) All containers shall be positioned so that the pressure relief valve is in direct communication with the vapor space of the container.

(c) Where physical damage to LP-Gas containers, or systems of which they are a part, from vehicles is a possibility, precautions against such damage shall be taken.

(d) The installation position of ASME containers shall make all container appurtenances accessible for their normally intended use.

(e) Field welding on containers shall be limited to attachments to nonpressure parts, such as saddle plates, wear plates or brackets applied by the container manufacturer. Welding to container proper shall comply with 2-2.1.6.

(f) Aboveground containers shall be kept properly painted.

3-2.3.2 Horizontal ASME containers designed for permanent installation in stationary service aboveground, except as provided in 3-2.3.2(a)(2)b and 3-2.3.2(b), shall be placed on substantial masonry or noncombustible structural supports on concrete or firm masonry foundations, and supported as follows:

(a) Horizontal containers shall be mounted on saddles in such a manner as to permit expansion and contraction, and not to cause an excessive concentration of stresses. Structural steel supports may be used as follows, or if in compliance with 3-2.3.2(b).

(1) Containers of more than 2,000 gal (7.6 m^3) water capacity shall be provided with concrete or masonry foundations formed to fit the container contour, or if furnished with saddles in compliance with 2-2.5.1, may be placed on flat-topped foundations.

(2) Containers of 2,000 gal (7.6 m^3) water capacity or less may be installed on concrete or masonry foundations formed to fit the container contour, or if equipped with attached supports complying with 2-2.5.2(a), may be installed as follows:

a. If the bottoms of the horizontal members of the container saddles, runners or skids are to be more than 12 in. (305 mm) above grade, fire-resistive foundations shall be provided. A container shall not be mounted with the outside bottom of the container shell more than 5 ft (1.5 m) above the surface of the ground.

b. For temporary use at a given location, not to exceed 6 months, fire-resistive foundations or saddles are not required provided the outside bottom of the container shell is not more than 5 ft (1.5 m) above the ground and that flexibility in the connecting piping is provided. (*See 2-4.6.3.*)

(3) Containers or container-pump assemblies mounted on a common base complying with 2-2.5.2(b) may be placed on paved surfaces or on concrete pads at ground level within 4 in. (102 mm) of ground level.

(b) With the approval of the authority having jurisdiction, single containers complying with 2-2.5.1 or 2-2.5.2 may be installed in isolated locations, with nonfireproofed steel supports resting on concrete pads or footings, provided the outside bottom of the container shell is not more than 5 ft (1.5 m) above the ground level.

(c) Suitable means of preventing corrosion shall be provided on that part of the container in contact with the saddles or foundations or on that part of the container in contact with masonry.

3-2.3.3 Vertical ASME containers over 2,000 gal (7.6 m^3) water capacity designed for permanent installation in stationary service aboveground shall be installed on reinforced concrete or steel structural supports on reinforced concrete foundations which are designed to meet the loading provisions established in 2-2.2.3.

(a) Steel supports shall be protected against fire exposure with a material having a fire resistance rating of at least two hours. Continuous steel skirts having only one opening 18 in. (457 mm) or less in diameter need such fire protection applied only to the outside of the skirts.

3-2.3.4 Single containers constructed as portable storage containers (*see definition*) for temporary stationary service in accordance with 2-2.5.4(a) shall be placed on concrete pads, paved surfaces or firm earth for such temporary service (normally not more than 12 months at a given location) and the following shall apply:

(a) The surface on which they are placed shall be substantially level and, if not paved, shall be cleared (and kept cleared) of dry grass and weeds, and other combustible material within 10 ft (3 m) of the container.

(b) Flexibility shall be provided in the connecting piping.

(c) If such containers are to be set with the bottoms of the skids or runners above the ground, nonfireproofed structural supports may be used for isolated locations with the approval of the authority having jurisdiction, and provided the height of the outside bottom of the container shell above the ground does not exceed 5 ft (1.5 m). Otherwise, fire-resistive supports shall be provided.

3-2.3.5 If the container is mounted on, or is part of, a vehicle as provided in 2-2.5.4(b), the unit shall be parked in compliance with the provisions of 3-2.2.2 as to the location of a container of that capacity for normal stationary service, and in accordance with the following:

(a) The surface shall be substantially level and if not paved shall be suitable for heavy vehicular use, and shall be cleared (and kept cleared) of dry grass and weeds, and other combustible material within 10 ft (3 m) of the container.

(b) Flexibility shall be provided in the connecting piping.

3-2.3.6 Portable containers of 2,000 gal (7.6 m^3) water capacity or less complying with 2-2.5.5 may be installed for stationary service as provided in 3-2.3.2(a)(2) for stationary containers.

3-2.3.7 Mounded containers shall be installed as follows:

(a) Mounding material shall be earth or sand and shall provide minimum thickness of cover for the container of at least 1 ft (305 mm).

(b) Unless inherently resistant to erosion, a suitable protective cover shall be provided.

3-2.3.8 ASME container assemblies or container systems listed for underground installation, or container assemblies listed for interchangeable aboveground-underground service, may be installed underground as follows:

(a) The top of the container shall be at least 6 in. (152 mm) below grade, unless the container might be subject to abrasive action or physical damage from vehicular traffic or from other causes such as in LP-Gas service stations. In this case, it shall be placed not less than 2 ft (610 mm) below grade or equivalent protection shall be otherwise provided (such as by the use of a concrete slab) to prevent imposing the weight of a loaded vehicle directly on the container shell.

(b) The portion of the container to which the manhole or other connections are attached need not be covered. However, where necessary, protection of the manhole and other connections against vehicular traffic damage shall be provided. When there is the possibility of a manhole or housing becoming flooded, the discharge from the regulator vent lines shall be above the highest probable water level.

(c) Containers shall be protected against corrosion for the soil conditions at the container site by a method in accordance with good engineering practice. Precaution shall be taken to prevent damage to the coating during handling. Any damage to the coating shall be repaired before backfilling.

(d) Containers shall be set substantially level on a firm foundation (firm earth may be used) and surrounded by earth or sand firmly tamped in place. Backfill shall be free of rocks or similar abrasives.

(e) When a container is to be abandoned underground, the following procedure shall be followed:

(1) Remove as much liquid LP-Gas as possible through the container liquid withdrawal connection.

(2) Remove as much of the remaining LP-Gas vapor as possible by venting it through a vapor connection; either burning this vapor, or venting it to the open air at a safe location. THe vapor shall not be vented at such a rapid rate as to exceed the vaporization rate of any residual liquid LP-Gas left after the liquid removal procedure of 3-2.3.8(e)(1).

NOTE: If vapor is vented too rapidly the pressure drop due to the refrigeration of the liquid may lead to the erroneous conclusion that no liquid remains in the container.

(3) When only vapor LP-Gas at atmospheric pressure remains in the container, it shall be filled with water, sand or foamed plastic, or purged with an inert gas. The displaced vapor may be burned or vented to the open air at a safe location.

3-2.3.9 Partially underground, unmounded ASME containers shall be installed as follows:

(a) The portion of the container below the surface, and for a vertical distance of at least 3 in. (75 mm) above the surface, shall be protected to resist corrosion as required for underground containers. [*See 3-2.3.8(c).*]

(b) Containers shall be set substantially level on a firm foundation, with backfilling to be as required for underground containers. (*See 3-2.3.8.*)

(c) Spacing provisions shall be as specified for aboveground containers in 3-2.2.2 and Table 3-2.2.2.

(d) The container shall be located so as not to be subject to vehicular damage, or shall be adequately protected against such damage.

3-2.4 Installation of Container Appurtenances.

3-2.4.1 Pressure relief devices shall be installed on containers in accordance with 3-2.4.2 through 3-2.4.5 and positioned so that the relief device is in direct communication with the vapor space of the container.

3-2.4.2 Pressure relief devices on portable DOT cylinder specification containers, or their equivalent of ASME construction, of 1,000 lb (454 kg) [120 gal (0.5 m^3)] water capacity or less, shall be installed to minimize the possibility of relief device(s) discharge(s) impingement on the container.

3-2.4.3 Pressure relief devices on ASME containers of 125 gal (0.5 m^3) water capacity or more permanently installed in stationary service, portable storage containers (see definition), portable containers (tanks) of nominal 120 gal (0.5 m^3) water capacity or more, or cargo tanks shall be installed so that any gas released is vented away from the container upward and unobstructed to the open air. The following provisions shall also apply:

(a) Means shall be provided, such as rain caps, to minimize the possibility of the entrance of water or other extraneous matter (which might render the relief device inoperative or restrict its capacity) into the relief device or any discharge piping. If necessary, provision shall be made for drainage. The rain cap or other protector shall be designed to remain in place except when the relief device operates and shall permit the relief device to operate at sufficient relieving capacity.

(b) On each aboveground container of more than 2,000 gal (7.6 m^3) water capacity, the relief device discharge shall be virtually upward and unobstructed to the open air at a point at least 7 ft (2 mm) above the top of the container. The following also shall apply:

(1) Relief device discharge piping shall comply with 3-2.4.3(f).

(2) In providing for drainage in accordance with 3-2.4.3(a), the design of relief device discharge(s) and attached piping shall:

a. Be such as to protect the container against flame impingement which might result from ignited product escaping from the drain opening.

b. Be directed so that a container(s), piping or equipment which might be installed adjacent to container on which the relief device is installed is not subjected to flame impingement.

(c) On underground containers of 2,000 gal (7.6 m^3) or less water capacity, except those installed in LP-Gas service stations covered in 3-2.4.3(e), the relief device may discharge into the manhole or housing, provided such manhole or housing is equipped with ventilated louvers, or their equivalent, of adequate area as specified in 3-2.4.6(d).

(d) On underground containers of more than 2,000 gal (7.6 m^3) water capacity, except those installed in LP-Gas service stations, the discharge from relief devices shall be piped vertically and directly upward to a point at least 7 ft (2 m) above the ground. Relief device discharge piping shall comply with 3-2.4.3(f).

(e) On underground containers in LP-Gas service stations, the relief device discharge shall be piped vertically and directly upward to a point at least 10 ft (3 m) above the ground. Discharge piping shall comply with 3-2.4.3(f) and shall be adequately supported and protected against physical damage.

(f) The discharge terminals from relief devices shall be located so as to provide protection against physical damage. Discharge piping used shall be adequate in size to permit sufficient relief device relieving capacity. Such piping shall comply with 3-2.7.2 or 3-2.7.3. Return bends and restrictive pipe or tubing fittings shall not be used.

(g) Shutoff valves shall not be installed between relief devices and the container, or between the relief devices and the discharge piping, except for specially designed relief device-shutoff valve combinations covered by 2-3.2.4(c), or where two or more separate relief devices are installed, each with its individual shutoff valve, and the shutoff valve stems are mechanically interconnected in a manner which will allow the rated relieving capacity required for the container from the relief device or devices which remain in communication with the container.

3-2.4.4 Pressure relief devices on portable storage containers (constructed and installed in accordance with 2-2.5.4 and 3-2.3.4 respectively) used temporarily in stationary type service shall be installed in accordance with the applicable provisions of 3-2.4.3.

3-2.4.5 Additional provisions (over and above the applicable provision in 3-2.4.2 and 3-2.4.3) apply to the installation of pressure relief devices in containers used in connection with vehicles as follows:

(a) For containers installed on vehicles in accordance with Sections 3-6 and 3-9.

(b) For cargo containers (tanks) installed on cargo vehicles in accordance with Section 6-3, see 6-3.2.1(a).

3-2.4.6 Container appurtenances other than pressure relief devices shall be installed and protected as follows:

(a) All container openings except those used for pressure relief devices (*see 2-3.2*), liquid level gauging devices (*see 2-3.4*), pressure gauges (*see 2-3.5*), those equipped with double check valves as allowed in Table 2-3.3.2, and plugged openings shall be equipped with internal valves [*see 2-3.3.3(d)*] or with positive shutoff valves and either excess-flow or backflow check valves (*also see 2-3.3 for specific application*) as follows:

(1) Except for DOT cylinders, excess-flow or backflow check valves shall be located between the LP-Gas in the container and the shutoff valves, either inside the container, or at a point immediately outside where the line enters or leaves the container. If outside, installation shall be made so that any undue strain beyond the excess-flow or backflow check valve will not cause breakage between the container and such valve. All connections, including couplings, nozzles, flanges, standpipes and manways, which are listed on the ASME Manufacturers' Data Report for the container, are considered part of the container. On DOT cylinders, the excess-flow valve where required may be located at the outlet of the cylinder shutoff valve.

(2) Shutoff valves shall be located as close to the container as practicable. The valves shall be readily accessible for operation and maintenance under normal and emergency conditions, either because of location or by means of permanently installed special provisions. Valves installed in an unobstructed location not more than 6 ft (1.8 m) above ground level shall be considered accessible. Special provisions include, but are not limited to, stairs, ladders, platforms, remote operators or extension handles.

(3) The connections, or line, leading to or from any individual opening shall have greater capacity than the rated flow of the excess-flow valve protecting the opening.

(b) Valves, regulators, gauges and other container appurtenances shall be protected against physical damage.

(c) Valves in the assembly of portable multicontainer systems shall be arranged so that replacement of containers can be made without shutting off the flow of gas in the system. This provision shall not be construed as requiring an automatic changeover device.

(d) Connections to containers installed underground shall be located within a substantial dome, housing or manhole and with access thereto protected by a substantial cover. Underground systems shall be installed so that all terminals for connecting hose and any opening through which there can be a flow from pressure relief devices or pressure regulator vents are located above the normal maximum water table. Terminals for connecting hoses, openings for flow from pressure relief devices, and the interior of domes, housing and manholes shall be kept clean of debris. Such manholes or housings shall be provided with ventilated louvers or their equivalent. The area of such openings shall equal or exceed the combined discharge areas of the pressure relief devices and other vent lines which discharge into the manhole or housing.

(e) Container inlet and outlet connections, except pressure relief devices, liquid level gauging devices and pressure gauges, on containers of 2,000 gal (7.6 m^3) water capacity or more, or on containers of any capacity used in LP-Gas service stations, shall be labeled to designate whether they communicate with the vapor or liquid space. Labels may be on valves. (*See Sections 3-6 and 3-9 for requirements for labeling smaller containers used for vehicular installations.*)

(f) Every storage container of more than 2,000 gal (7.6 m^3) water capacity, or of any capacity used in LP-Gas service stations, shall be provided with a suitable pressure gauge. (*See 3-3.5.*)

3-2.5 Regulator Installation.

3-2.5.1 Regulators used to control distribution or utilization pressure shall be as close to the container or vaporizer outlets as is practicable. First stage regulating equipment shall be outside of buildings except as used with containers and liquid piping systems covered by 3-2.2.1(a), (b), (d), (e) and (f), and 3-2.6.1(d).

3-2.5.2 Regulators shall be securely attached to container valves, containers, supporting standards or building walls.

(a) First stage regulators shall be either directly connected to the container shutoff valve or outlet of vaporizer where used, unless attached thereto with flexibility provided in the connecting piping or the interconnecting piping of manifolded containers or vaporizers.

(b) All regulators for outdoor installations, except regulators used for portable industrial applications, shall be designed, installed, or protected so their operation will not be affected by the elements (freezing rain, sleet, snow, ice, mud, or debris) . This protection may be integral with the regulator.

3-2.5.3 On regulating equipment installed outside of buildings, the discharge from a pressure relief device shall be located not less than 3 ft (1 m) horizontally away from any building opening below the level of such discharge, and not beneath any building unless this space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter.

3-2.5.4 On regulators installed inside buildings, the discharge from the pressure relief device and from above the regulator and relief device diaphragms shall be vented to the outside air with the discharge outlet located not less than 3 ft (1 m) horizontally away from any building opening below the level of such discharge. This provision shall not apply to appliance regulators otherwise protected (*see NFPA 54*), or to regulators used in connection with containers in buildings as provided for in 3-2.2.1(a), (b), (d), (e) and (f).

3-2.6 Piping System Service Limitations.

3-2.6.1 This subsection describes the physical state (vapor or liquid) and pressure at which LP-Gas may be transmitted through piping systems under various circumstances:

(a) LP-Gas liquid or vapor may be piped at all normal operating pressures outside of buildings.

(b) Polyethylene piping systems shall be limited to vapor service not exceeding 30 psig (208 kPa gauge).

(c) LP-Gas vapor at pressures not exceeding 20 psig (138 kPa gauge) may be piped into any building.

(d) LP-Gas vapor at pressures exceeding 20 psig (138 kPa gauge) or LP-Gas liquid shall not be piped into any building except those meeting the following descriptions:

(1) Buildings, or separate areas of buildings, constructed in accordance with Chapter 7, and used exclusively to:

a. House equipment for vaporization, pressure reduction, gas mixing, gas manufacturing or distribution.

b. House internal combustion engines, industrial processes, research and experimental laboratories, or equipment or processing having a similar hazard.

Exception: Complete compliance with Chapter 7 for buildings, or separate areas of buildings, housing industrial processes and other occupancies cited in 3-2.6.1(d)(1)b may not be necessary depending upon the prevailing conditions. Construction of buildings or separate areas of buildings housing certain internal combustion engines is covered in NFPA 37.

(2) Buildings or structures under construction or undergoing major renovation, provided the temporary piping meets the provisions of 3-4.2 and 3-4.10.2.

(3) In buildings or structures other than those covered by 3-2.6.1(d)(1) and (2) in which liquid feed systems are used, liquid piping may enter the building or structure to connect to a vaporizer provided heavy walled seamless brass or copper tubing not exceeding ³⁄₃₂ in. (2.4 mm) internal diameter and with a wall thickness not less than ³⁄₆₄ in. (1.2 mm) is used.

3-2.7 Installation of Pipe, Tubing, Pipe and Tubing Fittings, Valves and Hose.

3-2.7.1 LP-Gas normally is transferred into containers as a liquid, but may also be conveyed as a liquid or vapor under container or lower regulated pressure. Metallic piping shall comply with the following:

(a) Piping used at pressures higher than container pressure, such as on the discharge side of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psig (2.4 MPa gauge).

(b) Vapor LP-Gas piping with operating pressures in excess of 125 psig (0.9 MPa gauge), and liquid piping not covered by 3-2.7.1(a), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(c) Vapor LP-Gas piping, subject to pressures of not more than 125 psig (0.9 MPa gauge), shall be suitable for a working pressure of at least 125 psig (0.9 MPa gauge).

3-2.7.2 Metallic pipe joints may be threaded, flanged, welded, or brazed using pipe and fittings complying with 2-4.2 and 2-4.4 as follows:

(a) When joints are threaded or threaded and back welded:

(1) For LP-Gas vapor at pressures in excess of 125 psig (0.9 MPa gauge), or for LP-Gas liquid, the pipe and nipples shall be Schedule 80 or

(2) For LP-Gas vapor at pressures of 125 psig (0.9 MPa gauge) or less, the pipe and nipples shall be Schedule 40 or heavier.

(b) When joints are welded or brazed:

(1) The pipe shall be Schedule 40 or heavier.

(2) The fittings or flanges shall be suitable for the service in which they are to be used.

(3) Brazed joints shall be made with a brazing material having a melting point exceeding 1,000°F (538°C).

(c) Gaskets used to retain LP-Gas in flanged connections in piping shall be resistant to the action of LP-Gas. They shall be made of metal or other suitable material confined in metal having a melting point over 1,500°F (816°C) or shall be protected against fire exposure, except that aluminum O-rings and spiral wound metal gaskets are acceptable. When a flange is opened, the gasket shall be replaced.

3-2.7.3 Metallic tubing joints may be flared, soldered or brazed using tubing and fittings, and solder or brazing material complying with 2-4.3 and 2-4.4.

3-2.7.4 Piping in systems shall be run as directly as is practicable from one point to another, and with as few restrictions, such as ells and bends, as conditions will permit, giving consideration to provisions of 3-2.7.5.

(a) Where condensation of vapor may occur, metallic and nonmetallic piping shall be pitched back to the container or suitable means provided for revaporizing the condensate.

3-2.7.5 Provision shall be made in piping including interconnecting of permanently installed containers, to compensate for expansion, contraction, jarring and vibration, and for settling. Where necessary, flexible connectors complying with 2-4.6 may be used. (*See 3-2.7.8.*) The use of nonmetallic pipe, tubing or hose for permanently interconnecting such containers is prohibited.

3-2.7.6 Metallic piping outside buildings may be underground or aboveground or both. Aboveground piping shall be well supported and protected against physical damage. Where underground piping is beneath driveways, roads or streets, possible damage by vehicles shall be taken into account. Nonmetallic piping, including the nonmetallic portions of transition fittings, shall be installed outside, a minimum of 12 in. (305 mm) underground and in accordance with the piping manufacturers' instructions.

3-2.7.7 Underground metallic piping shall be protected against corrosion as warranted by soil conditions. Corrosion protection shall comply with the following:

(a) Underground piping shall be protected as needed with a suitable coating to retard the effects of the corrosion conditions existing in the local soil. Coated pipe shall extend at least 6 in. (152 mm) aboveground on all risers.

(b) When dissimilar metals are joined underground, an insulating fitting shall be installed to electrically isolate them from each other.

(c) If cathodic protection is used, insulating fittings shall be installed to electrically isolate the cathodically protectd underground system from all aboveground piping and systems.

(d) LP-Gas piping shall not be used as a grounding electrode.

3-2.7.8 Flexible components used in piping systems shall comply with 2-4.6 for the service in which they are to be used, shall be installed in accordance with the manufacturer's instructions, and shall also comply with the following:

(a) Flexible connectors in lengths up to 36 in. (1 m) (*see 2-4.6.3 and 2-4.6.4*) may be used for liquid or vapor piping, on portable or stationary tanks, to compensate for expansion, contraction, jarring, vibration and settling. This is not to be construed to mean that flexible connectors shall be used if provisions were incorporated in the design to compensate for these effects.

(b) Hoses may be installed if flexibility is required for liquid or vapor transfer. The use of wet hose (*see 4-2.3.4 for explanation of term "wet hose"*) is recommended for liquid.

3-2.7.9 On new installations, and by December 31, 1980 on existing installations, (1) stationary single container systems of over 4,000 gal (15.1 m^3) water capacity, or (2) stationary multiple container systems with an aggregate water capacity of more than 4,000 gal (15.1 m^3) utilizing a common or manifolded liquid transfer line, shall comply with 3-2.7.9(a) and (b).

(a) When a hose or swivel type piping 1½ in. or larger is used for liquid transfer or a 1¼ in. or larger vapor hose or swivel type piping is used in this service (excluding flexible connectors in such liquid and vapor piping), an emergency shutoff valve complying with 2-4.5.4 shall be installed in the fixed piping of the transfer system within 20 ft (6 m) of lineal pipe from the nearest end of the hose or swivel type piping to which the hose or swivel type piping is connected. The preceding sizes are nominal. Where the flow is only in one direction, a backflow check valve may be used in lieu of an emergency shutoff valve if installed in the fixed piping downstream of the hose or swivel type piping, provided the backflow check valve has a metal-to-metal seat or a primary resilient seat with a secondary metal seat not hinged with combustible material. When either a liquid or vapor line has two or more hoses or swivel type piping of the sizes designated, either an emergency shutoff valve or a backflow check valve shall be installed in each leg of the piping.

(1) Emergency shutoff valves shall be installed so that the temperature sensitive element in the valve, or a supplemental temperature sensitive element [250°F (121°C) maximum] connected to actuate the valve, is not more than 5 ft (1.5 m) from the nearest end of the hose or swivel type piping connected to the line in which the valve is installed.

(b) The emergency shutoff valve(s) or backflow check valve(s) specified in 3-2.7.9(a) shall be installed in the plant piping so that any break resulting from a pull will occur on the hose or swivel type piping side of the connection while retaining intact the valves and piping on the plant side of the connection. This may be accomplished by use of concrete bulkheads or equivalent anchorage or by the use of a weakness or shear fitting. Such anchorage is not required for tank car unloading.

3-2.7.10 Hose may be used on the low pressure side of regulators to connect to other than domestic and commercial appliances as follows:

(a) The appliance connected shall be of a portable type.

(b) For use inside buildings, the hose shall be of a minimum length, not exceeding 6 ft (1.8 m) [except as provided for in 3-4.2.3(b)], and shall not extend from one room to another, nor pass though any partitions, walls, ceilings or floors (except as provided for in 3-4.3.7). It shall not be concealed from view or used in concealed locations. For use outside buildings, hose length may exceed 6 ft (1.8 m), but shall be kept as short as practicable.

(c) Hose shall be securely connected to the appliance. The use of rubber slip ends is not permissible.

(d) A shutoff valve shall be provided in the piping immediately upstream of the inlet connection of the hose. When more than one such appliance shutoff is located near another, precautions shall be taken to prevent operation of the wrong valve.

(e) Hose used for connecting appliances to wall or other outlets shall be protected against physical damage.

3-2.8 Hydrostatic Relief Valve Installation.

3-2.8.1 A hydrostatic relief valve complying with 2-4.7.1 or a device providing pressure relieving protection shall be installed in each section of piping (including hose) in which liquid LP-Gas can be isolated between shutoff valves so as to relieve the pressure which could develop from the trapped liquid to a safe atmosphere or product-retaining section.

3-2.9 Testing Piping Systems.

3-2.9.1 After assembly, piping systems (including hose) shall be tested and proven free of leaks at not less than the normal operating pressure. Piping within the scope of NFPA 54, *National Fuel Gas Code*, [*see 1-2.3.1(f)*], shall be pressure tested in accordance with that Code. Tests shall not be made with a flame.

3-2.10 Equipment Installation.

3-2.10.1 Pumps shall be installed as recommended by the manufacturer and in accordance with 3-2.10.1(a) through (c).

(a) Installation shall be made so that the pump casing shall not be subjected to excessive strains transmitted to it by the suction and discharge piping. This shall be accomplished by piping design, the use of flexible connectors or expansion loops, or by other effective methods, in accordance with good engineering practice.

(b) Positive displacement pumps shall be installed in accordance with 2-5.2.2.

(1) The bypass valve or recirculating device to limit the normal operating discharge pressure to not more than 350 psig (2.4 MPa gauge) shall discharge either into a storage container (preferably the supply container from which the product is being pumped) or into the pump suction.

(2) If this primary device is equipped with a shutoff valve, an adequate secondary device designed to operate at not more than 400 psig (2.8 MPa gauge) shall, if not integral with the pump, be incorporated in the pump piping. This secondary device shall be designed or installed so that it cannot be rendered inoperative, and shall discharge either into the supply container or into the pump suction.

(c) A pump operating control or disconnect switch shall be located near the pump. Remote control points shall be provided as necessary for other plant operations such as container filling, loading or unloading of cargo vehicles and tank cars, or operation of motor fuel dispensers.

3-2.10.2 Compressors shall be installed as recommended by the manufacturer and in accordance with 3-2.10.2 (a) and (b).

(a) Installation shall be made so that the compressor housing shall not be subjected to excessive strains transmitted to it by the suction and discharge piping. Flexible connectors may be used where necessary to accomplish this.

(b) If the compressor is not equipped with an integral means to prevent the LP-Gas liquid entering the suction (*see 2-5.3.3*), a suitable liquid trap shall be installed in the suction piping as close to the compressor as practicable.

3-2.10.3 The installation of vaporizers of the types covered by 2-5.4 is covered in Section 3-7 and of engine fuel vaporizers in Section 3-6. Integral vaporizing-burners, such as are used for weed burners or tar kettles, are considered to be part of these units (or "appliances"). For appliance installation standards, see Section 3-5.

3-2.10.4 Strainers shall be installed so that the strainer element can be serviced.

3-2.10.5 Liquid or vapor meters shall be installed as recommended by the manufacturer, and in compliance with the applicable provisions of 3-2.10.5(a) and (b).

(a) Liquid meters shall be securely mounted and shall be installed so that the meter housing is not subjected to excessive strains from the connecting piping. If not provided in the piping design, flexible connectors may be used where necessay to accomplish this.

(b) Vapor meters shall be securely mounted and installed so as to minimize the possibility of physical damage.

3-2.10.6 LP-Gas engine fuel dispensing devices installed in service stations shall be installed as recommended by the manufacturer and in accordance with 3-2.10.6(a) through (h).

(a) Installation shall not be within a building, but may be under weather shelter or canopy, provided this area is adequately ventilated and is not enclosed for more than 50 percent of its perimeter.

(b) Dispensing devices shall be located as follows:

(1) Not less than 10 ft (3 m) from aboveground storage containers of more than 2,000 gal (7.6 m^3) water capacity.

(2) Not less than 20 ft (6 m) from any building [not including canopies covered in 3-2.10.6(a)], basement, cellar, pit or line of adjoining property which may be built upon.

(3) Not less than 10 ft (3 m) from sidewalks, streets or thoroughfares.

(c) Dispensing devices shall either be installed on a concrete foundation or be part of a complete storage and dispensing unit mounted on a common base [to be mounted as provided in 3-2.3.1(b) and (d)]. In either case, they shall be adequately protected against physical damage.

(d) Control for the pump used to transfer LP-Gas through the dispensing device into motor vehicle tanks shall be provided at the device in order to minimize the possibility of leakage or accidental discharge. The following also shall apply:

(1) Means shall be provided at some point outside the dispensing device, such as a remote switch [*see 3-2.10.1(c)*], to shut off the power in the event of fire or accident.

(2) A manual shutoff valve and an excess-flow check valve of suitable capacity shall be located in the liquid line between the pump and dispenser inlet only when the dispensing device is installed at a remote location and not part of a complete storage and dispensing unit mounted on a common base.

(e) Provision shall be made for venting the LP-Gas contained in the dispenser to a safe location.

(f) The dispensing hose shall comply with 2-4.6. An excess-flow check valve, or an automatic shutoff valve [*see 2-3.3.3(d) and 2-4.5.4*] shall be installed at the terminus of the liquid piping at the point of attachment of the dispensing hose. A differential back pressure valve shall be considered as meeting this provision.

(g) Piping leading to, and within the dispenser, and the dispensing hose shall be provided with hydrostatic relief valves as specified in 3-2.8.1 (*see also 2-4.7.1*).

(h) No drains or blowoffs from the dispensing device shall be directed toward, or be in close proximity to sewer systems.

3-3 Distributing and Industrial LP-Gas Systems.

3-3.1 Application.

3-3.1.1 This section includes provisions for LP-Gas systems installed at distributing plants, industrial plants, and distributing points (*see definitions*). These provisions extend and modify the provisions of Section 3-2 for these applications.

3-3.2 General.

3-3.2.1 The location and installation of storage containers and the installation of container appurtenances, piping, and equipment shall comply with Section 3-2.

3-3.3 Installation of Liquid Transfer Facilities.

3-3.3.1 Points of transfer (*see definition*) or the nearest part of a structure housing transfer operations shall be located in accordance with 4-3.2 and 4-3.3.

3-3.3.2 Separate buildings, and attachments to or rooms within other buildings, housing points of transfer or transfer pumps and compressors, constructed or converted to such use after December 31, 1972, shall comply with Chapter 7.

3-3.3.3 The back of the railroad siding or the roadway surface at the transfer points shall be relatively level. Adequate clearances from buildings, structures or stationary containers shall be provided for the siding or roadway approaches to the unloading or loading points. Substantial bumpers shall be provided at the ends of sidings, and as necessary to protect storage containers and points of transfer.

3-3.3.4 Safeguards shall be provided to prevent the uncontrolled discharge of LP-Gas in the event of failure in the hose or swivel type piping. The provisions of 3-2.7.9 shall apply. For all other LP-Gas systems, the following shall apply:

(a) The connection, or connecting piping, larger than ½-inch internal diameter into which the liquid or vapor is being transferred shall be equipped with:

(1) A back-flow check valve, or

(2) An emergency shutoff valve complying with 2-4.5.4, or

(3) An excess-flow valve properly sized in accordance with 3-2.4.6(a)(3).

(b) The connection, or connecting piping, larger than ½ in. internal diameter from which the liquid or vapor is being withdrawn shall be equipped with:

(1) An emergency shutoff valve complying with 2-4.5.4, or

(2) An excess-flow valve properly sized in accordance with 3-2.4.6(a)(3).

3-3.3.5 See 4-2.3.6 for railroad tank car transfer operations.

3-3.3.6 If gas is to be discharged from containers inside a building, the installation provisions of 4-4.2.1 shall apply.

3-3.4 Installation of Gas Distribution Facilities.

3-3.4.1 This subsection applies to the installation of facilities used for gas manufacturing, gas storage, gas-air mixing and vaporization, and compressors not associated with liquid transfer.

3-3.4.2 Except as provided in 3-3.4.3 and 3-3.4.4, separate buildings, and attachments to or rooms within other buildings, housing gas distribution facilities, constructed or converted to such use after December 31, 1972, shall comply with Chapter 7.

3-3.4.3 Facilities for vaporizing LP-Gas and gas-air mixing shall be designed, located and installed in accordance with Section 3-7.

3-3.4.4 Facilities for storing LP-Gas in portable containers at industrial plants and distributing points shall comply with Chapter 5.

3-3.4.5 Buildings housing vapor compressors shall be located in accordance with 4-3.3.2 considering the building as one housing a point of transfer.

3-3.4.6 The use of pits to house gas distribution facilities shall be avoided unless automatic flammable vapor detecting systems are installed in the pit. Drains or blowoff lines shall not be directed into or in proximity of sewer systems.

3-3.4.7 If gas is to be discharged from containers inside a building, the installation provisions of 4-4.2.1 shall apply.

3-3.5 Installation of Electrical Equipment.

3-3.5.1 Installation of electrical equipment shall comply with Section 3-8.

3-3.6 Protection Against Tampering for Section 3-3 Systems.

3-3.6.1 To minimize the possibilities for trespassing and tampering, the area which includes container appurtenances, pumping equipment, loading and unloading facilities and container filling facilities shall be protected by one of the following methods:

(a) Enclosure with at least a 6-ft (1.8-m) high industrial-type fence, unless otherwise adequately protected. There shall be at least two means of emergency access from the fenced or other enclosure. Clearance shall be provided to permit maintenance to be performed and a clearance of at least 3 ft (1 m) shall be provided to allow emergency access to the required means of egress. If guard service is provided, it shall be extended to the LP-Gas installation. Guard personnel shall be properly trained. (*See 1-6.1.1.*)

Exception: If a fenced or otherwise enclosed area is not over 100 sq ft (9 m²) in area, the point of transfer is within 3 ft (1 m) of a gate and containers being filled are not located within the enclosure, a second gate need not be provided.

(b) As an alternate to fencing the operating area, suitable devices which can be locked in place shall be provided. Such devices, when in place, shall effectively prevent unauthorized operation of any of the container appurtenances, system valves or equipment.

3-3.7 Lighting.

3-3.7.1 If operations are normally conducted during other than daylight hours, adequate lighting shall be provided to illuminate storage containers, containers being loaded, control valves and other equipment.

3-3.8 Ignition Source Control.

3-3.8.1 Ignition source control shall comply with Section 3-8.

3-4 LP-Gas Systems in Buildings or on the Roofs of Buildings.

3-4.1 Application.

3-4.1.1 This section includes installation and operating provisions for LP-Gas systems containing liquid LP-Gas located inside of, or on the roofs of, buildings or structures. Systems covered include those utilizing portable containers inside or on the roofs of buildings, and those in which the liquid is piped from outside containers into buildings or onto the roof. These systems are permitted only under the conditions specified in 3-4.1.1(a) through (c) and in accordance with 3-4.2.1 through 3-4.2.7. Containers in use shall mean connected for use.

(a) The portable use of containers indoors shall be only for the purposes specified in 3-4.3 through 3-4.8. Such use shall be limited to those conditions where operational requirements make portable use of containers necessary and location outside is impractical.

(b) Permanent installations using portable containers on roofs shall be as specified in 3-4.9. Such use shall be limited to those conditions where operational requirements make portable use of containers necessary and location not on roofs of buildings or structures is impractical.

(c) Liquid LP-Gas shall be piped into buildings or structures only for the purposes specified in 3-2.6.1(d).

3-4.1.2 These provisions are in addition to those specified in Section 3-2.

3-4.1.3 Liquid transfer systems are covered in Chapter 4.

3-4.1.4 Engine fuel systems used inside buildings are covered in Section 3-6.

3-4.1.5 LP-Gas transport or cargo vehicles stored, serviced or repaired in buildings are covered in Chapter 6.

3-4.2 General Provisions for Containers, Equipment, Piping and Appliances.

3-4.2.1 Containers shall comply with DOT cylinder specifications (*see 2-2.1.3 and 2-2.2.1*), shall not exceed 245 lb (111 kg) water capacity [nominal 100 lb (45 kg) LP-Gas capacity] each, shall comply with other applicable provisions of Section 2-2, and be equipped as provided in Section 2-3 (*see 2-3.3 and Table 2-3.3.2*). They shall also comply with the following:

(a) Containers shall be marked as provided in 2-2.6.

(b) Containers with water capacities greater than 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall be equipped with shutoff and excess-flow valves as provided in 2-3.3.2 (Column 3, Table 2-3.3.2). The installation of excess-flow valves shall take into account the type of valve protection provided for the container in accordance with 2-2.4.1.

(c) Valves on containers shall be protected in accordance with 2-2.4.1.

(d) Containers having water capacities greater than 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] connected for use shall stand on a firm and substantially level surface. If necessary, they shall be secured in an upright position.

(e) Containers and the valve protecting devices used with them shall be oriented so as to minimize the possibility of impingement of the pressure relief device discharge on the container and adjacent containers.

3-4.2.2 Regulators, if used, shall be suitable for use with LP-Gas. Manifolds and fittings connecting containers to pressure regulator inlets shall be designed for at least 250 psig (1.7 MPa gauge) service pressure.

3-4.2.3 Piping, including pipe, tubing, fittings, valves and hose, shall comply with Section 2-4, except that a minimum working pressure of 250 psig (1.7 MPa gauge) shall apply to all components. The following also shall apply:

(a) Piping shall be installed in accordance with the provisions of 3-2.7 for liquid piping or for vapor piping for pressures above 125 psig (0.9 MPa gauge). [*See 3-2.7.1(b)*]

(b) Hose, hose connections and flexible connectors used shall be designed for a working pressure of at least 350 psig (2.4 MPa gauge), shall comply with 2-4.6, and be installed in accordance with 3-2.7.10. Hose length may exceed that specified by 3-2.7.10(b), but shall be as short as practicable, although long enough to permit compliance with the spacing requirements (*see 3-4.3.3 and 3-4.3.4*) without kinking or straining hose or causing it to be close enough to a burner to be damaged by heat. See 3-4.9 for permanent roof installations.

3-4.2.4 Containers, regulating equipment, manifolds, pipe, tubing and hose shall be located so as to minimize exposure to abnormally high temperatures (such as might result from exposure to convection and radiation from heating equipment or installation in confined spaces), physical damage or tampering by unauthorized persons.

3-4.2.5 Heat producing equipment shall be located and used so as to minimize the possibility of the ignition of combustibles.

3-4.2.6 When containers are located on a floor or roof, provisions shall be made to minimize the possibility of containers falling over the edge.

(a) Filling containers on roofs is prohibited. See 4-3.1.1(b).

3-4.2.7 Portable heaters, including salamanders, shall be equipped with an approved automatic device to shut off the flow of gas to the main burner, and pilot if used, in the event of flame extinguishment or combustion failure. Such portable heaters shall be self-supporting unless designed for container mounting (*see 3-4.3.4*). Container valves, connectors, regulators, manifolds, piping or tubing shall not be used as structural supports. The following shall also apply:

(a) Portable heaters manufactured on or after May 17, 1967, having an input of more than 50,000 Btuh (53 MJ/h), and those manufactured prior to May 17, 1967, with inputs of more than 100,000 Btuh (105 MJ/h), shall be equipped with either:

(1) A pilot which must be lighted and proved before the main burner can be turned on, or

(2) An approved electric ignition system.

(b) The provisions of 3-4.2.7 are not applicable to the following:

(1) Tar kettle burners, hand torches or melting pots.

(2) Portable heaters with less than 7,500 Btuh (8 MJ/h) input if used with containers having a maximum water capacity of 2½ lb (1 kg).

3-4.3 Buildings Under Construction or Undergoing Major Renovation.

3-4.3.1 Containers may be used in buildings or structures under construction or undergoing major renovation when such buildings are not occupied by the public or, if partially occupied by the public, containers may be used in the unoccupied portions with the prior approval of the authority having jurisdiction. Such use shall be in accordance with 3-4.3.1 through 3-4.3.9.

3-4.3.2 Containers, equipment, piping and appliances shall comply with 3-4.2.

3-4.3.3 For temporay heating, such as curing concrete, drying plaster and similar applications, heaters (other than integral heater-container units covered in 3-4.3.4) shall be located at least 6 ft (1.8 m) from any LP-Gas container.

3-4.3.4 Integral heater-container units specifically designed for the attachment of the heater to the container, or to a supporting standard attached to the container, may be used, provided they are designed and installed so as to prevent direct or radiant heat application to the container. Blower and radiant type units shall not be directed toward any LP-Gas container within 20 ft (6 m).

3-4.3.5 If two or more heater-container units of either the integral or nonintegral type are located in an unpartitioned area on the same floor, the container(s) of each such unit shall be separated from the container(s) of any other such unit by at least 20 ft (6 m).

3-4.3.6 If heaters are connected to containers manifolded together for use in an unpartitioned area on the same floor, the total water capacity of containers manifolded together serving any one heater shall not be greater than 735 lb (333 kg) [nominal 300 lb (136 kg) LP-Gas capacity], and if there is more than one such manifold it shall be separated from any other by at least 20 ft (6 m).

3-4.3.7 On floors on which no heaters are connected for use, containers may be manifolded together for connection to a heater or heaters on another floor, provided:

(a) The total water capacity of the containers connected to any one manifold is not greater than 2,450 lb (1111 kg) [nominal 1,000 lb (454 kg) LP-Gas capacity], and

(b) Manifolds of more than 735 lb (333 kg) water capacity [nominal 300 lb (136 kg) LP-Gas capacity], if located in the same unpartitioned area, shall be separated from each other by at least 50 ft (15 m).

3-4.3.8 The provisions of 3-4.3.5, 3-4.3.6 and 3-4.3.7 may be altered by the authority having jurisdiction if compliance is impractical.

3-4.3.9 Storage of containers awaiting use shall be in accordance with Chapter 5.

3-4.4 Buildings Undergoing Minor Renovation When Frequented by the Public.

3-4.4.1 Containers may be used for repair or minor renovation in buildings frequented by the public as follows:

(a) During the hours of the day the public normally is in the building the following shall apply:

(1) The maximum water capacity of individual containers shall be 50 lb (23 kg) [nominal 20 lb (9 kg) LP-Gas capacity] and the number of containers in the building shall not exceed the number of workers assigned to using the LP-Gas.

(2) Containers having a water capacity greater than 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall not be left unattended.

(b) During the hours of the day when the building is not open to the public, containers may be used in the building for repair or minor renovation in accordance with 3-4.2 and 3-4.3, provided, however, that containers with a greater water capacity than 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] shall not be left unattended.

3-4.5 Buildings Housing Industrial Occupancies.

3-4.5.1 Containers may be used in buildings housing industrial occupancies for processing, research or experimental purposes as follows:

(a) Containers, equipment and piping used shall comply with 3-4.2.

(b) If containers are manifolded together, the total water capacity of the connected containers shall be not more than 735 lb (333 kg) [nominal 300 lb (136 kg) LP-Gas capacity]. If there is more than one such manifold in a room, it shall be separated from any other by at least 20 ft (6 m).

(c) The amount of LP-Gas in containers for research and experimental use in the building shall be limited to the smallest practical quantity.

3-4.5.2 Containers may be used to supply fuel for temporary heating in buildings housing industrial occupancies with essentially noncombustible contents, if portable equipment for space heating is essential and a permanent heating installation is not practicable, provided containers and heaters comply with and are used in accordance with 3-4.3.

3-4.6 Buildings Housing Educational and Institutional Occupancies.

3-4.6.1 Containers may be used in buildings housing educational and institutional laboratory occupancies for research and experimental purposes, but not in classrooms, as follows:

(a) The maximum water capacity of individual containers used shall be:

(1) 50 lb (23 kg) [nominal 20 lb (9 kg) LP-Gas capacity] if used in educational occupancies.

(2) 12 lb (5.4 kg) [nominal 5 lb (2 kg) LP-Gas capacity] if used in institutional occupancies.

(b) If more than one such container is located in the same room, the containers shall be separated by at least 20 ft (6 m).

(c) Containers not connected for use shall be stored in accordance with Chapter 5, except that they shall not be stored in a laboratory room.

3-4.7 Temporary Heating in Buildings in Emergencies.

3-4.7.1 Containers may be used in buildings for temporary emergency heating purposes if necessary to prevent damage to the buildings or contents, and if the permanent heating system is temporarily out of service, provided the containers and heaters comply with and are used in accordance with 3-4.2 and 3-4.3, and the temporary heating equipment is not left unattended.

3-4.8 Use in Buildings for Demonstrations or Training, or in Small Containers.

3-4.8.1 Containers having a maximum water capacity of 12 lb (5.4 kg) [nominal 5 lb (2 kg) LP-Gas capacity] may be used temporarily inside buildings for public exhibitions or demonstrations, including use in classroom demonstrations. If more than one such container is located in the same room, the containers shall be separated by at least 20 ft (6 m).

3-4.8.2 Containers may be used temporarily in buildings for training purposes related to the installation and use of LP-Gas systems, provided:

(a) The maximum water capacity of individual containers shall be 245 lb (111 kg) [nominal 100 lb (45 kg) LP-Gas capacity], but not more than 20 lb (9 kg) of LP-Gas may be placed in a single container.

(b) If more than one such container is located in the same room, the containers shall be separated by at least 20 ft (6 m).

(c) The training location shall be acceptable to the authority having jurisdiction.

(d) Containers shall be promptly removed from the building when the training class has terminated.

3-4.8.3 Containers having a maximum water capacity of 2½ lb (1 kg) [nominal 1 lb (0.45 kg) LP-Gas capacity] may be used in buildings as part of approved self-contained torch assemblies or similar appliances other than mobile cooking appliances.

3-4.9 Permanent Installations Using Portable Containers on Roofs.

3-4.9.1 Containers may be installed on roofs of buildings of fire-resistive construction, or noncombustible construction having essentially noncombustible contents, or of other construction or contents which are protected with automatic sprinklers (*see NFPA 220, Standard on Types of Building Construction*) in accordance with 3-4.2 and the following:

(a) The total water capacity of containers connected to any one manifold shall not be greater than 980 lb (445 kg) [nominal 400 lb (181 kg) LP-Gas capacity]. If more than one manifold is located on the roof, it shall be separated from any other by at least 50 ft (15 m).

(b) Containers shall be located in areas where there is free air circulation, at least 10 ft (3 m) from building openings (such as windows and doors) and at least 20 ft (6 m) from air intakes of air conditioning and ventilating systems.

(c) Containers shall not be located on roofs which are entirely enclosed by parapets more than 18 in. (457 mm) high unless either, (1) the parapets are breached with low-level ventilation openings no more than 20 ft (6 m) apart, or (2) all openings communicating with the interior of the building are at or above the top of the parapets.

(d) Containers shall not be refilled on roofs.

(e) The container valve outlet shall be tightly plugged and the provisions of 2-2.4.1 shall be complied with during movement of containers within a building. Only emergency stairways not generally used by the public shall be used and reasonable precautions shall be taken to prevent the container from falling down the stairs. Freight or passenger elevators may be used when not occupied by the public.

(f) Piping shall be in accordance with 3-4.2.3, provided, however, that hose shall not be used for connecting to containers.

(g) The fire department shall be advised of each such installation.

3-4.10 Liquid Piped into Buildings or Structures.

3-4.10.1 Liquid LP-Gas piped into buildings in accordance with 3-2.6.1(d)(1) shall comply with 3-2.7.

3-4.10.2 Liquid LP-Gas piped into buildings in accordance with 3-2.6.1(d)(2) from containers located and installed outside the building or structure in accordance with 3-2.2 and 3-2.3 shall comply with the following:

(a) Liquid piping shall not exceed ¾ in. I.P.S. and shall comply with 3-2.6 and 3-2.7. If approved by the authority having jurisdiction, copper tubing complying with 2-4.3.1(c)(1) and with a maximum outside diameter of ¾ in. may be used. Liquid piping in buildings shall be kept to a minimum, and shall be protected against construction hazards by:

(1) Securely fastening it to walls or other surfaces to provide adequate protection against breakage.

(2) Locating it so as to avoid exposure to high ambient temperatures.

(b) A readily accessible shutoff valve shall be located at each intermediate branch line where it leaves the main line. A second shutoff valve shall be located at the appliance end of the branch and upstream of any flexible appliance connector.

(c) Excess-flow valves complying with 2-3.3.3(b) and 2-4.5.3 shall be installed in the container outlet supply line, downstream of each shutoff valve, and at any point in the piping system where the pipe size is reduced. They shall be sized for the reduced size piping.

(d) Hose shall not be used to carry liquid between the container and the building, or at any point in the liquid line except as the appliance connector. Such connectors shall be as short as practicable and shall comply with 2-4.6, 3-2.7.8 and 3-2.7.10.

(e) Hydrostatic relief valves shall be installed in accordance with 3-2.8.

(f) Provision shall be made so that the release of fuel when any section of piping or appliances are disconnected shall be minimized by use of one of the following methods:

(1) An approved automatic quick-closing coupling which shuts off the gas on both sides when uncoupled.

(2) Closing the shutoff valve closest to the point to be disconnected and allowing the appliance or appliances on that line to operate until the fuel in the line is consumed.

3-5 Installation of Appliances.

3-5.1 Application.

3-5.1.1 This section includes installation provisions for LP-Gas appliances fabricated in accordance with Section 2-6.

3-5.1.2 Installation of appliances on commercial vehicles is covered in Section 3-9.

3-5.1.3 With the approval of the authority having jurisdiction, unattended heaters used for the purpose of animal or poultry production inside structures without enclosing walls need not be equipped with an automatic device designed to shut off the flow of gas to main burners and pilot, if used, in the event of flame extinguishment or combustion failure.

3-5.2 Reference Standards.

3-5.2.1 LP-Gas appliances shall be installed in accordance with this standard and other national standards which may apply. These include:

(a) NFPA 54, *National Fuel Gas Code* (ANSI Z223.1).

(b) NFPA 37, *Stationary Combustion Engines and Gas Turbines*.

(c) NFPA 501A, *Firesafety Criteria for Mobile Home Installations, Sites and Communities*

(d) NFPA 501C, *Recreational Vehicles* (ANSI A119.2).

(e) NFPA 96, *Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment*.

(f) NFPA 86A, *Ovens and Furnaces*.

(g) NFPA 82, *Incinerators, Waste and Linen Handling Systems and Equipment*.

(h) NFPA 302, *Motor Craft* (Pleasure and Commercial).

(i) NFPA 61B, *Grain Elevators and Bulk Handling Facilities*.

3-6 Engine Fuel Systems.

3-6.1 Application.

3-6.1.1 This section applies to fuel systems using LP-Gas as a fuel for internal combustion engines. Included are provisions for containers, container appurtenances, carburetion equipment, piping, hose and fittings and provisions for their installation. This section covers engine fuel systems for engines installed on vehicles for any purpose, as well as fuel systems for stationary and portable engines. It also includes provisions for garaging of vehicles upon which such systems are installed.

See Section 3-9 for systems on vehicles for purposes other than for engine fuel.

3-6.1.2 Containers supplying fuel to stationary engines, or to portable engines used in lieu of stationary engines, shall be installed in accordance with Section 3-2 (*see Section 3-4 for portable engines used in buildings, structures or on roofs under certain conditions*).

3-6.1.3 Containers supplying fuel to engines on vehicles, regardless of whether the engine is used to propel the vehicle or is mounted on it for other purposes, shall be constructed and installed in accordance with this section.

3-6.1.4 In the interest of safety, each person engaged in installing, repairing, filling or otherwise servicing an LP-Gas engine fuel system shall be properly trained in the necessary procedures.

3-6.2 General Purpose Vehicle Engines Fueled by LP-Gas.

3-6.2.1 This section covers the installation of fuel systems supplying engines used to propel vehicles such as passenger cars, taxicabs, multipurpose passenger vehicles, buses, recreational vehicles, vans, trucks (including tractors, tractor semi trailer units and truck trains) and farm tractors.

3-6.2.2 Containers.

(a) Containers designed, fabricated, tested and marked (or stamped) in accordance with the regulations of the US Department of Transportation (DOT);[1] or the *Rules for Construction of Unfired Pressure Vessels*, Section VIII, Division I, ASME *Boiler and Pressure Vessel Code*, applicable at the date of manufacture shall be used as follows:

(1) Adherence to applicable ASME *Code Case Interpretations and Addenda* shall be considered as compliance with the ASME Code.

(2) Containers fabricated to earlier editions of Regulations, Rules or Codes may be continued in use in accordance with 1-2.4.1. (*See Appendices B and C.*)

(3) Containers which have been involved in a fire shall have been requalified for continued service before being reused in accordance with the code under which they were constructed.

(4) DOT containers shall be designed and constructed for at least 240 psig (1.6 MPa gauge) service pressure.

(5) DOT specification containers shall be requalified in accordance with DOT regulations. The owner of the container shall be responsible for such requalification. (*See Appendix B.*)

(6) ASME containers covered in this section shall be constructed for a minimum 250 psig (1.7 MPa gauge) design pressure except that containers installed in enclosed spaces on vehicles and all engine fuel containers for industrial trucks shall be constructed for at least a 312.5 psig (2.1 MPa gauge) design pressure. (*See TIA 58-83-1.*)

(7) Welding for the repair or alterations of containers shall comply with the Regulations, Rules or Code under which the container was fabricated. Field welding on containers shall be limited to attachments to nonpressure parts, such as saddle pads, wear plates, lugs or brackets applied by the container manufacturer.

(b) Containers shall comply with 3-6.2.2(a) or shall be designed, fabricated, tested and marked using criteria which incorporate an investigation to determine that they are safe and suitable for the proposed service, are recommended for that service by the manufacturer, and are acceptable to the authority having jurisdiction.

(c) ASME containers shall be marked in accordance with 3-6.2.2(c)(1) through (12). The markings specified shall be on a metal name plate attached to the container, and so located as to remain visible after the container is installed.

(1) Service for which the container is designed; i.e., above ground.

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[1] Prior to April 1, 1967, these regulations were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply. Available from the Canadian Transport Commission, Union Station, Ottawa, Canada.

(2) Name and address of container manufacturer or trade name of container.

(3) Water capacity of container in lb or US Gallons.

(4) Design pressure in psig.

(5) The wording "This container shall not contain a product having a vapor pressure in excess of 215 psig at 100°F (37.8°C)."

(6) Tare weight of container fitted for service for containers to be filled by weight.

(7) Outside surface area in sq ft.

(8) Year of manufacture.

(9) Shell thickness _____ head thickness _____.

(10) OL _____ OD_____ HD _____.

(11) Manufacturer's Serial Number.

(12) ASME Code Symbol.

(d) LP-Gas fuel containers used on passenger carrying vehicles shall not exceed 200 gal (0.8 m^3) aggregate water capacity.

(e) Individual LP-Gas containers used on other than passenger carrying vehicles normally operating on the highway shall not exceed 300 gal (1 m^3) water capacity.

(f) Containers covered in this section shall be equipped for filling into the vapor space and shall not have more than two plugged openings.

(1) The connections for pressure relief valves shall be located and installed in such a way as to have direct communication with the vapor space of the container and shall not reduce the relieving capacity of the relief device.

(g) The container openings, except those for pressure relief valves and gauging devices, shall be labeled to designate whether they communicate with the vapor or liquid space. Labels may be on valves.

3-6.2.3 Container Appurtenances.

(a) Container appurtenances (such as valves and fittings) shall comply with Section 2-3 and 3-6.2.3(a)(1) through (6). Container appurtenances subject to working pressures in excess of 125 psig (0.9 MPa gauge) but not to exceed 250 psig (1.7 MPa gauge) shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(1) Manual shutoff valves shall be designed to provide positive closure under service conditions and be equipped with an internal excess-flow check valve designed to close automatically at the rated flows of vapor or liquid specified by the manufacturers.

(2) Double back flow check valves shall be of the spring loaded type and shall close when flow is either stopped or reversed. This valve shall be installed in the fill opening of the container for either remote or direct filling.

(3) Containers shall be fabricated so they can be equipped with a fixed liquid level gauge capable of indicating the maximum permitted filling level in accordance with 4-5.2.3. Fixed liquid level gauges in the container shall be designed so the bleeder valve maximum opening to the atmosphere is not larger than a No. 54 drill size. If the bleeder valve is installed at a remote location away from the container, the container fixed liquid level gauge opening and the remote bleeder valve shall be orificed to a No. 54 drill size.

(4) ASME containers shall be equipped with internal type spring loaded pressure relief valves conforming with applicable requirements of the "Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas," UL 132; Standards for Safety Relief Valves of the Factory Mutual Research Corporation; or other equivalent pressure relief valve standards. The start-to-leak setting of such pressure relief valve, with relation to the design pressure of the container, shall be in accordance with Table 2-3.2.5. These relief valves shall be plainly and permanently marked with (1) the pressure in psig (MPa) at which the valve is set to start to leak; (2) the rated relieving capacity in cu ft per minute of air at 60°F (15.6°C) and 14.7 psia (0.1 MPa absolute); and (3) the manufacturer's name and catalog number. Fusible plugs shall not be used.

(5) DOT containers shall be equipped with internal pressure relief valves in accordance with DOT regulations (*see Appendix D for additional information*). Fusible plugs shall not be used.

(6) A float gauge if used shall be designed and approved for use with LP-Gas.

(7) A solid steel plug shall be installed in unused openings.

(8) Containers fabricated after June 30, 1983 for use as engine fuel containers on vehicles shall be equipped or fitted with an automatic means to prevent filling in excess of the maximum permitted filling density.

a. An over-filling prevention device may be installed on the container or exterior of the compartment when remote filling is used, provided that a double back check valve is installed in the container fill valve opening.

3-6.2.4 Carburetion Equipment.

(a) Carburetion equipment shall comply with 3-6.2.4(b) through (e) or shall be designed, fabricated, tested and marked using criteria which incorporate an investigation to determine that they are safe and suitable for the proposed service, are recommended for that service by the manufacturer, and are acceptable to the authority having jurisdiction. Carburetion equipment subject to working pressures in excess of 125 psig (0.9 MPa gauge) but not to exceed 250 psig (1.7 MPa gauge) shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(b) Vaporizer.

(1) Vaporizers shall be fabricated of materials suitable for LP-Gas service and resistant to the action of LP-Gas under service conditions. Such vaporizers shall be designed and approved for engine fuel service and shall comply with the following:

a. The vaporizer proper, any part of it or any devices used with it which may be subjected to container pressure, shall have a design pressure of at least 250 psig (1.7 MPa gauge), where working pressures do not exceed 250 psig (1.7 MPa gauge), and shall be plainly and permanently marked at a readily visible point with a design pressure of the fuel containing portion in psig (MPa).

(2) The vaporizer shall not be equipped with a fusible plug.

(3) Each vaporizer shall have a valve or suitable plug located at or near the lowest portion of the section occupied by the water or other heating liquid to permit substantially complete drainage. The engine cooling system drain or water hoses may serve this purpose, if effective.

(4) Engine exhaust gases may be used as a direct source of heat to vaporize the fuel if the materials of construction of those parts of the vaporizer in contact with the exhaust gases are resistant to corrosion from these gases and if the vaporizer system is designed to prevent pressure in excess of 200 psig (1.4 MPa gauge).

(5) Devices which supply heat directly to the fuel container shall be equipped with an automatic device to cut off the supply of heat before the pressure in the container reaches 200 psig (1.4 MPa gauge).

(c) Regulator. The regulator shall be approved and can either be part of the vaporizer unit or a separate unit.

(d) Automatic Shutoff Valve. An approved automatic shutoff valve shall be provided in the fuel system as close as practical to the inlet of the gas regulator. The valve shall prevent flow of fuel to the carburetor when the engine is not running even if the ignition switch is in the "on" position. Atmospheric type regulators (zero governors) shall not be considered as automatic shutoff valves for this purpose.

(e) Fuel Filter. Fuel filters if used shall be approved and can be either a separate unit or part of a combination unit.

3-6.2.5 Piping, Hose and Fittings.

(a) Pipe.

(1) Pipe shall be wrought iron or steel (black or galvanized), brass or copper and shall comply with the following:

a. Wrought iron pipe; ANSI B36.10, *Wrought-Steel and Wrought Iron Pipe*.

b. Steel pipe; ANSI B125.1, *Welded and Seamless Steel Pipe* (ASTM A53).

c. Steel pipe; ANSI B125.30, *Seamless Carbon Steel Pipe for High Temperature Service* (ASTM A106).

d. Steel pipe; ANSI B125.2, *Black and Hot Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses* (ASTM A120).

e. Brass pipe; ANSI H27.1, *Seamless Red Brass Pipe* (ASTM B43).

f. Copper pipe; ANSI H26.1, *Seamless Copper Pipe* (ASTM B42).

(2) For LP-Gas vapor in excess of 125 psig (0.9 MPa gauge) or for LP-Gas liquid, the pipe shall be schedule 80 or heavier. For LP-Gas vapor at pressures of 125 psig (0.9 MPa gauge) or less, the pipe shall be Schedule 40 or heavier.

(b) Tubing.

(1) Tubing shall be steel, brass or copper and shall comply with the following:

a. Steel tubing; ASTM A539, *Electric-Resistance Welded Coiled Steel Tubing for Gas and Oil Lines*, with a minimum wall thickness of 0.049 in.

b. Copper tubing; Type K or L, ANSI H23.1, *Seamless Copper Water Tube* (ASTM B88).

c. Copper tubing; ANSI H23.5, *Seamless Copper Tube for Air Conditioning and Refrigeration Field Service* (ASTM B280).

d. Brass tubing; ANSI H36.1, *Seamless Brass Tube* (ASTM B135).

(c) Pipe and Tube Fittings.

(1) Cast iron pipe fittings such as ells, tees, crosses, couplings, unions, flanges or plugs shall not be used. Fittings shall be steel, brass, copper, malleable iron or ductile iron and shall comply with the following:

a. Pipe joints in wrought iron, steel, brass or copper pipe may be screwed, welded or brazed. Tubing joints in steel, brass or copper tubing shall be flared, soldered or brazed or made up with approved gas tubing fittings.

(i) Fittings used with liquid LP-Gas, or with vapor LP-Gas at operating pressures over 125 psig (0.9 MPa gauge), where working pressures do not exceed 250 psig (1.7 MPa gauge), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

(ii) Fittings for use with vapor LP-Gas at pressures in excess of 5 psig (34.5 kPa gauge) and not exceeding 125 psig (0.9 MPa gauge) shall be suitable for a working pressure of 125 psig (0.9 MPa gauge).

(iii) Soldering or brazing filler material shall have a melting point exceeding 1,000°F (538°C).

(d) Hose, Hose Connections and Flexible Connectors.

(1) Hose, hose connections and flexible connectors (*see definition*) used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psig (34.5 kPa gauge) shall be fabricated of materials resistant to the action of LP-Gas both as liquid and vapor, and be of wire braid reinforced construction. The wire braid shall be stainless steel. The hose shall comply with the following:

a. Hose shall be designed for a minimum bursting pressure 1,750 psig (12 MPa gauge) [350 psig (2.4 MPa gauge) working pressure] and shall be marked with "LP-Gas" or "LPG" and with the working pressure in psig at not greater than 10-ft (3-m) intervals.

b. Hose assemblies after the application of connections shall have a design capability of withstanding a pressure of not less than 700 psig (4.8 MPa gauge). If a test is made, such assemblies shall not be leak tested at pressures higher than the working pressure [350 psig (2.4 MPa gauge) minimum] of the hose.

(2) Hose used for vapor service at 5 psig (34.5 kPa gauge) or less shall be constructed of material resistant to the action of LP-Gas.

(3) Hose in excess of 5 psig (34.5 kPa gauge) service pressure and quick connectors shall have the approval for this application of any of the authorities listed in 1-3.1.1.

3-6.2.6 Installation of Containers and Container Appurtenances.

(a) Containers shall be located in a place and in a manner to minimize the possibility of damage to the container and its fittings. Containers located in the rear of the vehicles, when protected by substantial bumpers, shall be considered in conformance with this requirement. In case the fuel container must be installed near the engine or exhaust system, it shall be shielded against direct heating.

(b) Container markings shall be readable after a container is permanently installed on a vehicle. A portable lamp and mirror may be used when reading markings.

(c) Container valves, appurtenances and connections shall be adequately protected to prevent damage due to accidental contacts with stationary objects or from stones, mud or ice thrown up from the ground, and from damage due to overturn or similar vehicular accident. Location on the container where parts of the vehicle furnish the necessary protection or a fitting guard furnished by the manufacturer of the container may meet these requirements.

(d) Containers shall not be mounted directly on roofs or ahead of the front axle or beyond the rear bumper of the vehicles. So as to minimize the possibility of physical damage, no part of a container or its appurtenances shall protrude beyond the sides or top of the vehicle at the point where it is installed.

(e) Containers shall be installed with as much road clearance as practicable. This clearance shall be measured to the bottom of the container or the lowest fitting, support or attachment on the container or its housing, if any, whichever is lowest, as follows [*see Figure 3-6.2.6(e)*]:

(1) Containers installed between axles shall comply with 3-6.2.6(e)(3) or be not lower than the lowest of the following points and surfaces:

a. The lowest point forward of the container on:

(i) the lowest structural component of the body;

(ii) the lowest structural component of the frame or subframe, if any;

(iii) the lowest point on the engine;

(iv) the lowest point on the transmission (including the clutch housing or torque converter housing, as applicable) [Part 1, Figure 3-6.2.6(e)], and

b. not lower than a surface defined by two intersecting planes, the first plane being defined by the following three points:

(i) the intersection of (a) a vertical plane parallel to and midway between the axles of the vehicle and (b) the lowest point of the vehicle intercepted by that plane [Point A, Part 2, Figure 3-6.2.6(e)];

(ii) the perpendicular projection from the center of the end of the axle of the front right wheel to a horizontal plane surface beneath and in contact with the front right tire (Point BR, Part 2), and

(iii) the perpendicular projection from the center of the end of the axle of the front left wheel to a horizontal plane surface beneath and in contact with the front left tire (Point BL, Part 2),

and the second plane being defined by

(iv) said intersection (Point A);

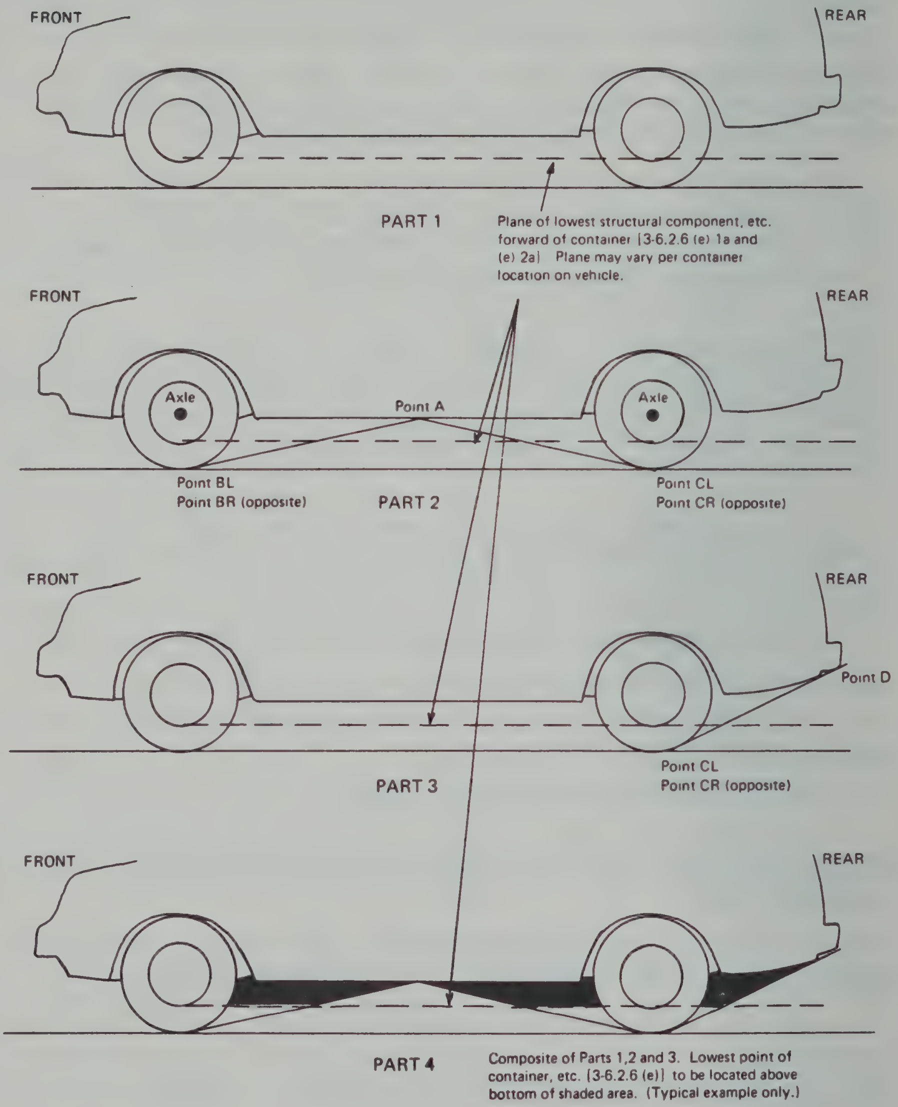
FRONT
REAR
PART 1
Plane of lowest structural component, etc. forward of container [3-6.2.6 (e) 1a and (e) 2a] Plane may vary per container location on vehicle.
FRONT
REAR
Axle
Axle
Point A
Point BL
Point BR (opposite)
PART 2
Point CL
Point CR (opposite)
FRONT
REAR
Point D
Point CL
Point CR (opposite)
PART 3
FRONT
REAR
PART 4
Composite of Parts 1,2 and 3. Lowest point of container, etc. [3-6.2.6 (e)] to be located above bottom of shaded area. (Typical example only.)

Figure 3-6.2.6(e) Container Installation Clearances

(v) the perpendicular projection from the center of the end of the axle of the rear right wheel to a horizontal plane surface beneath and in contact with the rear right tire (Point CR, Part 2), and

(vi) the perpendicular projection from the center of the end of the axle of the rear left wheel to a horizontal plane surface beneath and in contact with the rear left tire (Point CL).

c. Where there are two or more rear axles, the projections shall be made from the frontmost one of them.

(2) Containers installed behind the rear axle and extending below the frame shall comply with 3-6.2.6(e)(3) or be not lower than the lowest of the following points and surfaces:

a. The lowest point on

(i) the lowest structural component of the body, forward of the container;

(ii) the lowest point, forward of the container, on the engine;

(iii) the lowest point, forward of the container, on the transmission (including the clutch housing or torque converter housing, as applicable) (Part 1), and

b. not lower than a surface defined by the following three points:

(i) the perpendicular projection from the center of the end of the axle of the right rear wheel to a horizontal plane surface beneath and in contact with the right rear tire (Point CR);

(ii) the perpendicular projection from the center of the end of the axle of the rear left wheel to a horizontal plane surface beneath and in contact with the rear left tire (Point CL);

(iii) the initial point of structural interference rearward of either rear tire to ground (Point D, Part 3).

c. Where there are two or more rear axles, the projections shall be made from the rearmost one of them.

(3) Containers may be installed within the space in which the original manufacturer of the vehicle installed the LP-Gas container. Where an LP-Gas container is substituted for the container for a fuel other than LP-Gas which had been installed by the original manufacturer of the vehicle, the LP-Gas container must fit within the space in which the original fuel container was installed.

(f) Fuel containers shall be securely mounted to prevent jarring loose and slipping or rotating, and the fastenings shall be designed and constructed to withstand without permanent visible deformation static loading in any direction equal to four times the weight of the container filled with fuel.

(g) Welding for the repair or alterations of containers shall comply with 3-6.2.2(a)(7).

(h) Main shutoff valves on a container for liquid and vapor shall be readily accessible without the use of tools or other means shall be provided to shut off the container valves.

(i) Pressure relief valve installations shall comply with the following requirements:

(1) The relief valve discharge on fuel containers on vehicles other than passenger cars shall be directed upward within 15 degrees of vertical so that any gas released will not impinge upon containers or part of the vehicle, or on adjacent persons or vehicles or discharge inside of the passenger compartment. On passenger cars, the relief valve discharge on fuel containers shall be directed upward within 45 degrees of vertical so that gas may not be discharged inside of the passenger or luggage compartment and so that any gas released will not impinge upon a container, part of the vehicle or on an adjacent vehicle.

(2) Pressure relief valve discharge lines shall be metallic and have a melting point over 1500°F (816°C). Discharge lines and adaptors shall be sized, located and secured so as to minimize the possibility of physical damage and to permit required pressure relief valve discharge capacity. When the relief valve discharge must be piped away from the container, the relief valve shall be fitted with an approved break-away type adaptor or designed such that in the event of excessive stress the piping will break away without impairing the function of the relief valve. Flexible metal hose or tubing used shall be able to withstand the pressure from the relief vapor discharge when the relief valve is in full open position. A means shall be provided (such as loose fitting caps) to minimize the possibility of the entrance of water or dirt into either the relief valve or its discharge piping. The protecting means shall remain in place except when the relief valve operates. In this event, it shall permit the relief valve to operate at required capacity.

(3) Relief valve adaptors installed directly in the relief valve to deflect the flow upward shall be metallic and have a melting point over 700°F (371°C).

3-6.2.7 Containers Mounted in the Interior of Vehicles.

(a) Containers mounted in the interior of vehicles shall be installed so that any LP-Gas released from container appurtenances due to operation, leakage or connection of the appurtenances will not be in an area communicating directly with the driver or passenger compartment or with any space containing radio transmitters or other spark producing equipment. This may be accomplished by 3-6.2.7(a)(1) or (2).

(1) Locating the container, including its appurtenances, in an enclosure which is securely mounted to the vehicle, is gastight with respect to driver or passenger compartments and to any space containing radio transmitters or other spark producing equipment, and which is vented outside the vehicle.

a. The luggage compartment (trunk) of a vehicle may constitute such an enclosure provided it meets all these requirements.

(2) Enclosing the container appurtenances and their connections in a structure which is securely mounted on the container, is gastight with respect to the driver or passenger compartments or with any space carrying radio transmitters or other spark producing equipment, and which is vented to outside the vehicle.

(b) Fuel containers shall be installed and fitted so that no gas from fueling and gauging operations can be released inside of the passenger or luggage compartments, by permanently installing the remote filling connections (double backflow check valve), see 3-6.2.3(a)(2), and fixed liquid level gauging device to the outside of the vehicle.

(c) Container pressure relief valve installation shall comply with 3-6.2.6(i).

(d) Enclosures, structures, seals and conduits used to vent enclosures shall be fabricated of durable materials and be designed to resist damage, blockage or dislodgement through movement of articles carried in the vehicle or by the closing of luggage compartment enclosures or vehicle doors, and shall require the use of tools for removal.

3-6.2.8 Pipe and Hose Installation.

(a) The piping system shall be designed, installed, supported and secured in such a manner as to minimize the possibility of damage due to expansion, contraction, vibration, strains or wear, and to preclude any working loose while in transit.

(b) Piping (including hose) shall be installed in a protected location. If outside, piping shall be under the vehicle and below any insulation or false bottom. Fastening or other protection shall be installed to prevent damage due to vibration or abrasion. At each point where piping passes through sheet metal or a structural member, a rubber grommet or equivalent protection shall be installed to prevent chaffing.

(c) Fuel line piping which must pass through the floor of a vehicle shall be installed to enter the vehicle through the floor directly beneath, or adjacent to, the container. If a branch line is required, the tee connection shall be in the main fuel line under the floor and outside the vehicle.

(d) Exposed parts of the piping system shall either be of corrosion-resistant material or adequately protected against exterior corrosion.

(e) Piping systems, including hose, shall be tested and proven free of leaks at not less than normal operating pressure.

(f) There shall be no fuel connection between a tractor and trailer or other vehicle units.

(g) A hydrostatic relief valve shall be installed in each section of piping (including hose) in which liquid LP-Gas can be isolated between shutoff valves so as to relieve to a safe atmosphere the pressure which could develop from the trapped liquid. This hydrostatic relief valve shall have a pressure setting not less than 400 psig (2.8 MPa gauge) or more than 500 psig (3.5 MPa gauge).

3-6.2.9 Equipment Installation.

(a) Installation shall be made in accordance with the manufacturer's recommendations and, in the case of listed or approved equipment, it shall be installed in accordance with the listing or approval.

(b) Equipment installed on vehicles shall be considered a part of the LP-Gas system on the vehicle and shall be protected against vehicular damage in accordance with 3-6.2.6(a).

(c) The gas regulator and the approved automatic shutoff valve shall be installed as follows:

(1) Approved automatic pressure reducing equipment, properly secured, shall be installed between the fuel supply container and the carburetor to regulate the pressure of the fuel delivered to the carburetor.

(2) An approved automatic shutoff valve shall be provided in the fuel system in compliance with 3-6.2.4(d).

(d) Vaporizers shall be securely fastened in position.

3-6.3 Industrial (and Forklift) Trucks Powered by LP-Gas.

3-6.3.1 This subsection applies to LP-Gas installation on industrial trucks (including forklift trucks) both to propel them and to provide the energy for their materials handling attachments. LP-Gas fueled industrial trucks shall comply with NFPA 505, *Firesafety Standard for Powered Industrial Trucks Including Type Designations and Areas of Use*.

3-6.3.2 ASME and DOT fuel containers shall comply with 3-6.2.2 and 3-6.2.3(a)(1) through (7).

(a) Portable containers may be designed, constructed and fitted for filling in either the vertical or horizontal position, or if of the portable universal type [*see 2-3.4.2(c)(2)*], in either position. The container shall be in the appropriate position when filled or, if of the portable universal type, may be loaded in either position, provided:

(1) The fixed level gauge indicates correctly the maximum permitted filling level in either position.

(2) The pressure relief valves are located in, or connected to, the vapor space in either position.

3-6.3.3 The container relief valve shall be vented upward within 45 degrees of vertical and otherwise comply with 3-6.2.6(i).

3-6.3.4 Gas regulating and vaporizing equipment shall comply with 3-6.2.4(b)(1) through (5) and 3-6.2.4(c), (d) and (e).

3-6.3.5 Piping and hose shall comply with 3-6.2.5(a) through (d) except that hose 60 in. (1.5 m) in length or less need not be of stainless steel wire braid construction.

3-6.3.6 Industrial trucks (including forklift trucks) powered by LP-Gas engine fuel systems shall comply as to operation with NFPA 505, *Firesafety Standard for Powered Industrial Trucks Including Type Designations and Areas of Use*, and with the following:

(a) Refueling of such trucks shall be accomplished as follows:

(1) Trucks with permanently mounted containers shall be refueled out-of-doors.

(2) Exchange of removable fuel containers preferably should be done out-of-doors, but may be done indoors. If done indoors, means shall be provided in the fuel piping system to minimize the release of fuel when containers are exchanged, using one of the following methods:

a. Use of an approved quick-closing coupling (a type closing in both directions when uncoupled) in the fuel line, or

b. Closing the shutoff valve at the fuel container, and allowing the engine to run until the fuel in the line is exhausted.

(b) LP-Gas fueled industrial trucks may be used in buildings or structures as follows:

(1) The number of fuel containers on such a truck shall not exceed two.

(2) With the approval of the authority having jurisdiction, industrial trucks may be used in buildings frequented by the public, including the times when such buildings are occupied by the public. The total water capacity of the fuel containers on an individual truck shall not exceed 105 lb (48 kg) [nominal 45 lb (20 kg) LP-Gas capacity].

(3) Trucks shall not be parked and left unattended in areas occupied by or frequented by the public except with the approval of the authority having jurisdiction. If so left, the fuel system shall be checked to be sure there are no leaks and that the container shutoff valve is closed.

(4) In no case shall industrial trucks be parked and left unattended in areas of excessive heat or near sources of ignition.

3-6.4 General Provisions for Vehicles Having Engines Mounted on Them.

3-6.4.1 This subsection includes provisions for the installation of equipment on vehicles to supply LP-Gas as a fuel for engines mounted on these vehicles. The term "vehicles" includes any readily portable mobile unit, whether the engine is used to propel it or is mounted on it for other purposes.

3-6.4.2 Gas vaporizing, regulating, and carburetion equipment to provide LP-Gas as a fuel for engines shall be installed in accordance with 3-6.2.8 and 3-6.2.9.

(a) In the case of industrial trucks (including forklift trucks) and other engines on vehicles operatng in buildings other than those used exclusively to house engines, an approved automatic shutoff valve shall be provided in the fuel system in compliance with 3-6.2.4(d).

(b) The source of air for combustion shall be completely isolated from the driver and passenger compartment, ventilating system or air conditioning system on the vehicle.

3-6.5 Engine Installation Other Than on Vehicle.

3-6.5.1 Stationary engines and gas turbines installed in buildings, including portable engines used in lieu of, or to supplement, stationary engines, shall comply with NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, and the applicable provisions of Chapters 1 and 2 and Section 3-2 of this standard.

3-6.5.2 Portable engines, except as provided in 3-6.5.1, may be used in buildings only for emergencies and the following shall apply:

(a) The capacity of the LP-Gas containers used with such engines and the equipment used to provide fuel to them shall comply with the applicable provisions of Section 3-4.

(b) An approved automatic shutoff valve shall be provided in the fuel system in compliance with 3-6.2.4(d). Atmospheric type regulators (zero governors) used for portable engines of 12 horsepower or less with magneto ignition and used exclusively outdoors shall be considered as in compliance with 3-6.2.4(d).

(c) Provision shall be made to supply sufficient air for combustion and cooling. Exhaust gases shall be discharged to a point outside the building, or to an area in which they will not constitute a hazard.

3-6.5.3 Piping and hose shall comply with 3-6.2.5(a) through (d).

3-6.5.4 Gas regulating, vaporizing and carburetion equipment shall comply with 3-6.2.4(b)(1) through (5), 3-6.2.4(c) and 3-6.2.4(e).

3-6.5.5 Installation of piping, carburetion, vaporizing and regulating equipment for the engine fuel system shall comply with 3-6.2.8 and 3-6.2.9.

3-6.5.6 Engines installed or operated exclusively outdoors shall comply with 3-6.5.3, 3-6.5.4 and 3-6.5.5.

(a) Atmospheric type regulators (zero governor) shall be considered as automatic shutoff valves only in the case of completely outdoor operations, such as farm tractors, construction equipment or similar outdoor engine applications.

3-6.6 Garaging of Vehicles.

3-6.6.1 Vehicles with LP-Gas engine fuel systems mounted on them and general purpose vehicles propelled by LP-Gas engines may be stored or serviced inside garages, provided:

(a) The fuel system is leak free and the container(s) is not filled beyond the limits specified in Chapter 4.

(b) The container shutoff valve is closed when vehicles or engines are under repair except when engine is operated.

(c) The vehicle is not parked near sources of heat, open flames, or similar sources of ignition, or near inadequately ventilated pits.

3-7 Vaporizer Installation.

3-7.1 Application.

3-7.1.1 This section applies to the installaton of vaporizing devices covered in 2-5.4. It does not apply to engine fuel vaporizers, or to integral vaporizing-burners such as those used for weed burners or tar kettles.

3-7.2 Installation of Indirect-Fired Vaporizers.

3-7.2.1 Indirect-fired vaporizers shall comply with 2-5.4.2, and shall be installed as provided in 3-7.2.2 through 3-7.2.9.

3-7.2.2 Indirect vaporizers may be installed out-of-doors, in buildings used exclusively for gas manufacturing or distribution, or in separate structures constructed in accordance with Section 7-2. Any such buildings shall be well ventilated near the floor line and roof.

3-7.2.3 Indirect vaporizers may also be installed in structures attached to, or rooms within, buildings not used for gas manufacturing or distribution, provided such attached structures or rooms comply with Section 7-3, and that there are no openings of any sort from the vaporizer room into the building or structure of which it is a part.

3-7.2.4 The housing for the vaporizer covered by 3-7.2.2 or 3-7.2.3 shall not have any unprotected drains to sewers or sump pits. Pressure relief valves on vaporizers within buildings in industrial or gas manufacturing plants shall be piped to a point outside the building and shall discharge vertically upward.

3-7.2.5 The device supplying the heat necessary for producing steam, hot water, or other heating medium may be installed out-of-doors, in a separate building, or in a structure attached to, or room within, another gas manufacturing or distributing building (but not buildings used for other purposes), provided:

(a) The housing provided shall comply with either Section 7-2 or 7-3, and shall be well ventilated near the floor line and roof.

(b) The heat supplying device, if out-of-doors, or the housing in which it is installed, shall be located with respect to other LP-Gas facilities and operations as required by Section 3-8. If the heat supplying device is gas-fired and is packaged with the vaporizer, or installed within 15 ft (5 m) of the vaporizer, it shall be subject to the provisions of 3-7.3 covering installation of direct gas-fired vaporizers.

Exception: The requirements of 3-7.2.5 are not applicable to domestic water heaters supplying heat for domestic system vaporizers.

3-7.2.6 The heating medium piping into and from the vaporizer shall be provided with a suitable means for preventing the flow of gas into a heating system which is supplying heat to areas other than the LP-Gas facility in the event of a tube rupture in the vaporizer. If the device supplying the heat to the vaporizer is for that purpose only, the device, or the piping to and from the device, shall contain a relief valve, vented to the outside, to relieve excessive pressure in the event of a tube rupture in the vaporizer.

3-7.2.7 Gas-fired heating systems supplying heat for vaporization purposes shall be equipped with automatic safety devices to shut off gas to the main burners if the pilot light should fail.

3-7.2.8 Vaporizers may be an integral part of a fuel storage container, directly connected to either the liquid or vapor space, or to both. A limit control shall be provided to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment, or the pressure within the storage container above the pressure shown in the first column of Table 2-2.2.2 corresponding with the design pressure of the container (or its 1980 Code equivalent — see Note 1 of Table 2-2.2.2).

3-7.2.9 Atmospheric vaporizers employing heat from the ground or surrounding air shall be installed as follows:

(a) Buried underground, or

(b) Located inside a building close to the point of entry of the supply pipe, provided the capacity of the unit does not exceed one quart (0.9 L).

(c) Vaporizers of less than one quart (0.9 L) capacity, not equipped with pressure relief valves [*see 2-5.4.2(e)*], may be installed provided one of the authorities listed in 1-3.1.1 certifies that it is safe without such a valve.

(d) Vaporizers designed primarily for domestic service shall be protected against tampering and physical damage.

3-7.3 Installation of Direct Gas-Fired Vaporizers.

3-7.3.1 Direct gas-fired vaporizers shall comply with 2-5.4.3, and shall be installed as provided in 3-7.3.2 through 3-7.3.6.

3-7.3.2 Direct gas-fired vaporizers may be installed out-of-doors or in separate structures constructed in accordance with Section 7-2. Any such buildings shall be well ventilated near the floor line and roof.

3-7.3.3 Direct gas-fired vaporizers may also be installed in structures attached to, or in rooms within, a gas manufacturing or distributing structure (but not buildings used for other purposes), provided:

(a) The housing provided shall comply with Section 7-3, and shall be well ventilated near the floor line and roof.

(b) The wall separating it from all other compartments or rooms containing LP-Gas vaporizers, pumps and central gas mixing devices shall have no openings.

3-7.3.4 The housing for the vaporizer covered in 3-7.3.2 and 3-7.3.3 shall not have unprotected drains or sump pits. Pressure relief valves on vaporizers within buildings in industrial or gas manufacturing plants shall be piped to a point outside the building and shall discharge vertically upward.

3-7.3.5 Direct gas-fired vaporizers may be connected to the liquid space or to both the liquid and the vapor space of the container, but in any case there shall be a manually operated shutoff valve in each connection at the container, to permit completely shutting off all flow of vapor or liquid.

3-7.3.6 Direct gas-fired vaporizers of any capacity shall be located in accordance with Table 3-7.3.6.

Table 3-7.3.6

Exposure	Mimimum Distance Required
Container	10 ft (3 m)
Container shutoff valves	15 ft (5 m)
Point of transfer	15 ft (5 m)
Nearest important building or group of buildings or line of adjoining property which may be built upon (except buildings in which vaporizer is installed. See 3-7.3.2 and 3-7.3.3).	25 ft (7.6 m)
Gas-air mixing (*see 3-7.7*)	

3-7.4 Installation of Direct Gas-Fired Tank Heaters.

3-7.4.1 Gas-fired tank heaters shall comply with 2-5.4.5, and shall be installed as follows:

(a) The container heated by a direct gas-fired tank heater shall be located in accordance with Table 3-7.4.1 with respect to the nearest important building, group of buildings, or line of adjoining property which may be built upon.

Table 3-7.4.1

Container Water Capacity	Minimum Distance Required
500 gal or less	10 ft (3 m)
501 to 2000 gal	25 ft (7.6 m)
2001 to 30,000 gal	50 ft (15 m)
30,001 to 70,000 gal	75 ft (23 m)
70,001 to 90,000 gal	100 ft (30 m)
90,001 to 120,000 gal	125 ft (38 m)

For SI Units: 1 gal = 3.785 L

(b) Direct gas-fired tank heaters shall be attached to aboveground containers only.

(c) If a point of transfer is located within 15 ft (5 m) of a direct gas-fired tank heater, the heater burner and pilot shall be shut off during the product transfer and a caution notice shall be displayed immediately adjacent to the filling connections, stating the following:

"A gas-fired device which contains a source of ignition is connected to this container. Burner and pilot must be shut off before filling tank."

3-7.5 Installation of Vaporizing-Burners.

3-7.5.1 Vaporizing-burners shall comply with 2-5.4.6 and shall be installed as follows:

(a) Vaporizing-burners shall be installed outside of buildings. The minimum distance between any container and a vaporizing-burner shall be in accordance with Table 3-7.5.1.

Table 3-7.5.1

Container Water Capacity	Minimum Distance Required
500 gal or less	10 ft (3 m)
501 to 2000 gal	25 ft (7.6 m)
Over 2000 gal	50 ft (15 m)

For SI Units 1 gal = 3.785 L

(b) Manually operated positive shutoff valves shall be located at the containers to shut off all flow to the vaporizing-burners.

3-7.6 Installation of Waterbath Vaporizers.

3-7.6.1 Waterbath vaporizers shall comply with 2-5.4.4 and shall be installed as follows:

(a) If a waterbath vaporizer is electrically heated and all electrical equipment is suitable for Class 1, Group D locations, the unit shall be treated as indirect-fired and installed in accordance with 3-7.2.

(b) All others shall be treated as direct-fired vaporizers and installed in accordance with 3-7.3.

3-7.7 Installation of Gas-Air Mixers.

3-7.7.1 Gas-air mixing equipment shall be located at least 25 ft (7.6 m) from a direct-fired vaporizer when the mixer is installed outdoors. If the mixer is installed in a building, the building shall comply with the provisions of Chapter 7 and no direct-fired vaporizer is to be located within the same building enclosure. Such a structure shall be located at least 25 ft (7.6 m) from a direct-fired vaporizer.

3-7.7.2 Listed vaporizer-mixers in a common cabinet having a direct-fired type vaporizer shall be installed outdoors in accordance with the distance provisions in 3-7.3. Listed vaporizer-mixers not in a common cabinet having an indirect-fired type vaporizer may be installed in a building or structure complying with Chapter 7 provided there is no source of ignition in such building or structure.

3-8 Ignition Source Control.

3-8.1 Application.

3-8.1.1 This section includes provisions to minimize the possibility of ignition of flammable LP-Gas-air mixtures resulting from the normal or accidental release of nominal quantities of liquid or vapor from LP-Gas systems installed and operated in accordance with this standard.

3-8.1.2 Liquefied petroleum gas storage containers do not require lightning protection (*see NFPA 78, Lightning Protection Code*).

3-8.1.3 Since liquefied petroleum gas is contained in a closed system of piping and equipment, the system need not be electrically conductive or electrically bonded for protection against static electricity (*see NFPA 77, Recommended Practice on Static Electricity*).

3-8.2 Electrical Equipment.

3-8.2.1 Electrical equipment and wiring shall be of a type specified by and shall be installed in accordance with NFPA 70, *National Electrical Code*, for ordinary locations except that fixed electrical equipment in classified areas shall comply with 3-8.2.2.

3-8.2.2 Fixed electrical equipment and wiring installed within classified areas specified in Table 3-8.2.2 shall comply with Table 3-8.2.2 and shall be installed in accordance with NFPA 70, *National Electrical Code*. This provision does not apply to fixed electrical equipment at residential or commercial installations of LP-Gas systems or to systems covered by Section 3-9.

3-8.2.3 Electrical equipment installed on LP-Gas cargo vehicles shall comply with 6-1.1.5.

3-8.3 Other Sources of Ignition.

3-8.3.1 Open flames or other sources of ignition shall not be permitted in pump houses, container filling rooms or other similar locations. Direct-fired vaporizers or indirect-fired vaporizers attached or installed adjacent to gas-fired heat sources shall not be permitted in pump houses or container filling rooms.

3-8.3.2 Open flames (except as provided for in Section 3-7), cutting or welding, portable electric tools and extension lights capable of igniting LP-Gas shall not be permitted within classified areas specified in Table 3-8.2.2 unless the LP-Gas facilities have been freed of all liquid and vapor, or special precautions observed under carefully controlled conditions.

Table 3-8.2.2

Part	*Location*	*Extent of Classified Area*[1]	*Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D*[2]
A	Storage Containers Other Than DOT Cylinders.	Within 15 feet in all directions from connections, except connections otherwise covered in Table 3-8.2.2.	Division 2
B	Tank Vehicle and Tank Car Loading and Unloading.[3]	Within 5 feet in all directions from connections regularly made or disconnected for product transfer.	Division 1
		Beyond 5 feet but within 15 feet in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and grade. (See Figure 3-8.2.2)	Division 2
C	Gage Vent Openings Other Than Those On DOT Cylinders.	Within 5 feet in all directions from point of discharge.	Division 1
		Beyond 5 feet but within 15 feet in all directions from point of discharge.	Division 2
D	Relief Device Discharge Other Than Those on DOT Cylinders.	Within direct path of discharge.	Division 1 *Note:* Fixed electrical equipment should preferably not be installed.
		Within 5 feet in all directions from point of discharge.	Division 1
		Beyond 5 feet but within 15 feet in all directions from point of discharge except within the direct path of discharge.	Division 2

[1] The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

[2] See Article 500 — "Hazardous Locations" in NFPA No. 70 (ANSI) for definitions of Classes, Groups, and Divisions.

[3] When classifying extent of hazardous area, consideration shall be given to possible variations in the spotting of tank cars and tank vehicles at the unloading points and the effect these variations of actual spotting point may have on the point of connection.

(Continued)

Part	*Location*	*Extent of Classified Area*[1]	*Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D*[2]
E	Pumps, vapor compressors, gas-air mixers and vaporizers (other than direct-fired or indirect-fired with an attached or adjacent gas-fired heat source).		
	Indoors without ventilation.	Entire room and any adjacent room not separated by a gastight partition.	Division 1
		Within 15 feet of the exterior side of any exterior wall or roof that is not vaportight or within 15 feet of any exterior opening.	Division 2
	Indoors with adequate ventilation.[4]	Entire room and any adjacent room not separated by a gastight partition.	Division 2
	Outdoors in open air at or abovegrade.	Within 15 feet in all directions from this equipment and within the cylindrical volume between the horizontal equator of the sphere and grade. (See Figure 3-8.2.2)	Division 2
F	Service Station Dispensing Units.	Entire space within dispenser enclosure, and 18 inches horizontally from enclosure exterior up to an elevation 4 ft. above dispenser base. Entire pit or open space beneath dispenser.	Division 1
		Up to 18 inches abovegrade within 20 ft. horizontally from any edge of enclosure. *Note:* For pits within this area, see Part G of this table.	Division 2

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[1] The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

[2] See Article 500 — "Hazardous Locations" in NFPA No. 70 (ANSI) for definitions of Classes, Groups, and Divisions.

[4] Where specified for the prevention of fire or explosion during normal operation, ventilation is considered adequate where provided in accordance with the provisions of this standard.

(Continued)

Part	*Location*	*Extent of Classified Area*[1]	*Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D*[2]
G	Pits or trenches containing or located beneath LP-Gas valves, pumps, vapor compressors, regulators, and similar equipment.		
	Without mechanical ventilation.	Entire pit or trench	Division 1
		Entire room and any adjacent room not separated by a gastight partition.	Division 2
		Within 15 feet in all directions from pit or trench when located outdoors.	Division 2
	With adequate mechanical ventilation.	Entire pit or trench.	Division 2
		Entire room and any adjacent room not separated by a gastight partition.	Division 2
		Within 15 feet in all directions from pit or trench when located outdoors.	Division 2
H	Special Buildings or rooms for storage of portable containers.	Entire room.	Division 2
I	Pipelines and connections containing operational bleeds, drips, vents or drains.	Within 5 ft. in all directions from point of discharge.	Division 1
		Beyond 5 ft. from point of discharge, same as Part E of this table.	

[1] The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

[2] See Article 500 — "Hazardous Locations" in NFPA No. 70 (ANSI) for definitions of Classes, Groups, and Divisions.

(*Continued*)

Part	*Location*	*Extent of Classified Area*[1]	*Equipment Shall Be Suitable for National Electrical Code, Class 1, Group D*[2]
J	Container Filling:		
	Indoors with adequate ventilation[4]	Within 5 feet in all directions from connections regularly made or disconnected for product transfer.	Division 1
		Beyond 5 feet and entire room.	Division 2
	Outdoors in open air	Within 5 feet in all directions from connections regularly made or disconnected for product transfer.	Division 1
		Beyond 5 feet but within 15 feet in all directions from a point where connections are regularly made or disconnected and within the cylindrical volume between the horizontal equator of the sphere and grade. (See Figure 3-8.2.2)	Division 2

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[1] The classified area shall not extend beyond an unpierced wall, roof, or solid vaportight partition.

[2] See Article 500 — "Hazardous Locations" in NFPA No. 70 (ANSI) for definitions of Classes, Groups, and Divisions.

[4] Where specified for the prevention of fire or explosion during normal operation, ventilation is considered adequate where provided in accordance with the provisions of this standard.

SI Conversions for Table 3-8.2.2
18 in = 256 mm
4 ft = 1.2 m
5 ft = 1.5 m
15 ft = 5 m
20 ft = 6 m

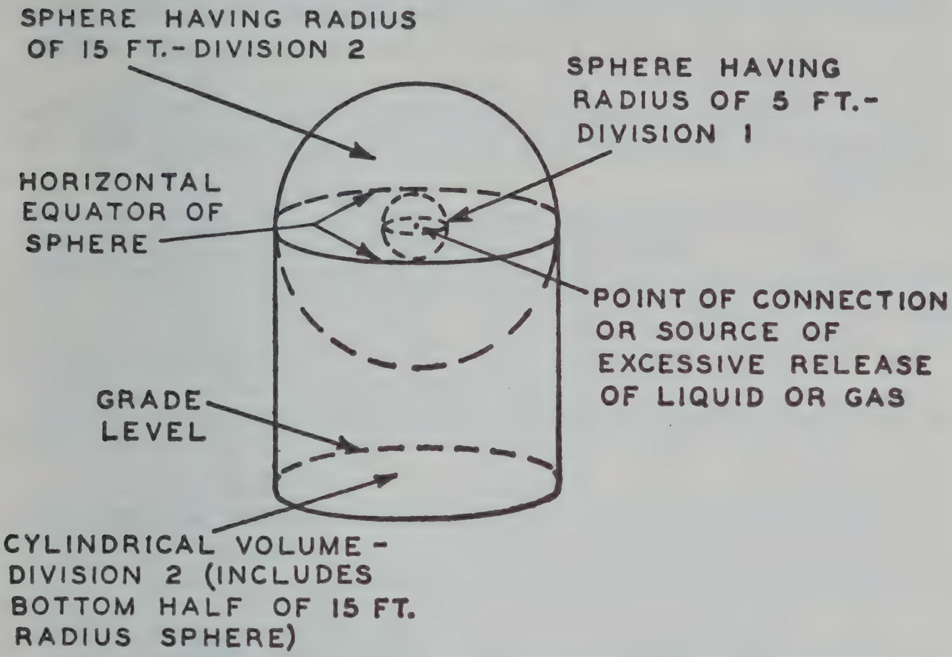
SPHERE HAVING RADIUS OF 15 FT.-DIVISION 2
SPHERE HAVING RADIUS OF 5 FT.-DIVISION 1
HORIZONTAL EQUATOR OF SPHERE
POINT OF CONNECTION OR SOURCE OF EXCESSIVE RELEASE OF LIQUID OR GAS
GRADE LEVEL
CYLINDRICAL VOLUME - DIVISION 2 (INCLUDES BOTTOM HALF OF 15 FT. RADIUS SPHERE)

Figure 3-8.2.2
(See Table 3-8.2.2)

3-8.4 Control of Ignition Sources During Transfer.

3-8.4.1 Sources of ignition shall be carefully controlled during transfer operations, while connections or disconnections are made, or while LP-Gas is being vented to the atmosphere. In addition to the other provisions of Section 3-8, the following shall apply:

(a) Internal combustion engines within 15 ft (5 m) of a point of transfer shall be shut down while such transfer operations are in progress, except as follows:

(1) Engines of LP-Gas cargo vehicles constructed and operated in compliance with Chapter 6 while such engines are driving transfer pumps or compressors on these vehicles to load containers as provided in 4-3.2.1.

(2) Engines installed in buildings as provided in 3-6.3.

(b) Smoking, open flames, metal cutting or welding, portable electrical tools and extension lights capable of igniting LP-Gas shall not be permitted within 15 ft (5 m) of a point of transfer while filling operations are in progress. Care shall be taken to assure that materials which have been heated have cooled before the transfer is started.

(c) Sources of ignition, such as pilot lights, burners, electrical appliances, and engines, located on the vehicle being refueled shall be turned off during the filling of any LP-Gas container on the vehicle.

3-8.4.2 Transfers to containers serving agricultural or industrial equipment requiring refueling in the field shall comply with the following:

(a) Air moving equipment, such as large blowers on crop driers or on space heaters, shall be shut down while containers are being refilled, unless the point of transfer is at least 50 ft (15 m) from the air intake of the blower.

(b) Equipment employing open flames, or equipment with integral containers such as flame cultivators, weed burners, tractors, large blower type space heaters or tar kettles shall be shut down while refueling.

3-9 LP-Gas Systems on Vehicles (Other Than Engine Fuel Systems.)

3-9.1 Application.

3-9.1.1 This section applies to non-engine fuel systems on commercial, industrial, construction and public service vehicles such as trucks, semitrailers, trailers, portable tar kettles, mobile laboratories, clinics and mobile cooking units (such as catering and canteen vehicles). LP-Gas systems on such vehicles may be either vapor-withdrawal or liquid-withdrawal type. Included are provisions for installations served by exchangeable (removable) container systems and by permanently mounted containers.

3-9.1.2 This section does not apply to:

(a) Systems installed on mobile homes.

(b) Systems installed on recreational vehicles [*see 3-1.1.4(d)*].

(c) Tank trucks, truck transports (trailers and semitrailers) and similar units used to transport LP-Gas as cargo, which are covered by Chapter 6.

3-9.1.3 LP-Gas engine fuel systems on the vehicles covered by Section 3-9 and those cited in 3-9.1.2 are covered by Section 3-6.

3-9.2 Construction, Location, Mounting and Protection of Containers and Systems.

3-9.2.1 Containers shall comply with Section 2-2 and appurtenances used to equip them for service shall comply with Section 2-3. In addition, 3-9.2.1(a) through (g) shall apply:

(a) ASME containers shall be constructed for a minimum 250 psig (1.7 MPa gauge) design pressure.

(b) Containers installed in enclosed spaces on vehicles (including recesses or cabinets covered in 3-9.2.2) shall be constructed as follows:

(1) DOT cylinder specification containers shall be designed and constructed for at least a 240 psig (1.6 MPa gauge) service pressure.

(2) ASME containers shall be constructed for at least a 312.5 psig (2.2 MPa gauge) design pressure.

(c) Portable (removable) containers shall comply with 2-2.4.

(d) Containers to be permanently mounted shall be constructed so that, after mounting the protection of all container appurtenances and the connections to these appurtenances, they comply with 3-9.2.3(c).

(e) LP-Gas fuel containers used on passenger-carrying vehicles shall not exceed 200 gal (0.8 m^3) aggregate water capacity.

(f) Individual LP-Gas containers used on other than passenger-carrying vehicles normally operating on the highway shall not exceed 300 gal (1 m^3) water capacity. This shall not be construed as applying to the use of LP-Gas from the cargo tanks of vehicles covered by Chapter 6.

(g) Containers designed for stationary service only, and not in compliance with 2-3.4, shall not be used.

3-9.2.2 Containers utilized for the purposes covered by this section shall not be installed, transported or stored (even temporarily) inside any vehicle covered by Section 3-9, except as provided in 3-9.2.3(d), Chapter 6 or as provided by applicable DOT regulations. The LP-Gas supply system, including the containers, may be installed on the outside of the vehicle, or in a recess or cabinet vaportight to the inside of the vehicle but accessible from and vented to the outside, with the vents located near the top and bottom of the enclosure, and 3 ft (1 m) horizontally away from any opening into the vehicle below the level of the vents.

3-9.2.3 Containers shall be securely mounted on the vehicle, or within the enclosing recess or cabinet, and located and installed so as to minimize the possibility of damage to containers, their appurtenances or contents as follows:

(a) Containers shall be installed with road clearance in accordance with 3-6.2.6(e).

(b) Fuel containers shall be securely mounted to prevent jarring loose and slipping or rotating, and the fastenings shall be designed and constructed to withstand without permanent visible deformation static loading in any direction equal to four times the weight of the container filled with fuel. When containers are mounted within a vehicle housing, the securing of the housing to the vehicle shall comply with this provision. Any hoods, domes or removable portions of the housing or cabinet shall be provided with means to keep them firmly in place in transit. Field welding shall comply with 3-2.3.1(e).

(c) All container valves, appurtenances and connections shall be adequately protected to prevent damage due to accidental contacts with stationary objects, from loose objects, stones, mud, or ice, thrown up from the ground or floor, and from damage due to overturned or similar vehicular accident. In the case of permanently mounted containers, this provision may be met by the location on the vehicle, with parts of the vehicle furnishing the protection. On portable (removable) containers the protection for container valves and connections shall be permanently attached to the container. (*See 2-2.4.1 and 2-2.4.2*). Such weather protection as may be necessary to ensure safe operation shall be provided for containers and systems mounted on the outside of the vehicle.

(d) Containers mounted on the interior of passenger-carrying vehicles shall be installed in compliance with 3-6.2.7. Pressure relief valve installations for such containers shall comply with 3-6.2.6(i).

3-9.2.4 Containers installed on portable tar kettles alongside the kettle, or on the vehicle frame, shall be protected against radiant or convected heat from open flame or other burners by the use of a heat shield or by the location of the container(s) on the vehicle so as to prevent the temperature of the fuel in the container from becoming abnormally high. In addition, the following shall apply:

(a) Container location, mounting and protection shall comply with 3-9.2.3(a), (b) and (c) except that the protection for DOT container valves need not be permanently attached to the container; however, the protection shall comply with 2-2.4.1(a) and (b);

(b) Piping shall comply with 3-9.2.7(a), (b), (d), (e), (g), (h), and (i);

(c) Flexible connections shall comply with 2-4.6.1, 2-4.6.2 and 2-4.6.3;

(d) Container valves shall be closed when burner is not in use;

(e) Containers shall not be refilled while burners are in use as provided in 3-8.4.2(b).

3-9.2.5 Container appurtenances shall be installed in accordance with 3-9.2.5(a) through (f).

(a) Container pressure relief devices shall be located and installed as follows:

(1) Except as provided in 3-9.2.3(d), pressure relief devices on portable containers installed inside cabinets or recesses complying with 3-9.2.2 may discharge within the enclosure.

(2) Relief device discharge outlets on containers installed on the outside of the vehicle shall be located:

a. Outside of enclosed spaces, at least 3 ft (1 m) horizontally away from any opening into the vehicle below the level of such discharge, and as far as practicable from sources of ignition.

b. In such a manner as to minimize the possibility of impingement of escaping gas upon a container, vehicle parts, or on other vehicles in adjacent lines of traffic.

(3) Pressure relief device discharge lines shall be metallic and have a melting point over 1500°F (816°C). Relief valve adaptors installed directly in the relief valve to deflect the flow upward shall be metallic and have a melting point over 700°F (371°C). Discharge lines and adaptors shall be sized, located and secured so as to permit sufficient pressure relief device relieving capacity. Flexible metal hose or tubing used shall be able to withstand the pressure from the relief device vapor discharge when the relief device is in full open position.

(4) On vehicles used outdoors or in industrial locations, means shall be provided (such as loose fitting caps) to minimize the possibility of the entrance of water or dirt into either the relief device or its discharge piping. The protecting means shall remain in place except when the relief device operates. In this event, it shall permit the relief device to operate at sufficient capacity.

(b) The filling, withdrawal and equalizing connections of containers shall be equipped in compliance with 2-3.3.1 through 2-3.3.3 (*see "Used as Fuel on Vehicles," Column 5 of Table 2-3.3.2*).

(c) Main shutoff valves on container for liquid and vapor shall be readily accessible.

(d) Containers to be filled volumetrically shall be equipped with liquid level gauging devices as provided in 2-3.4. Portable containers may be designed, constructed and fitted for filling in either the vertical or horizontal position or, if of the portable universal type [*see 2-3.4.1(c)(2)*], in either position. The container shall be in the appropriate position when filled or, if of the portable universal type, may be loaded in either position, provided:

(1) The fixed level gauge indicates correctly the maximum permitted filling level in either position.

(2) The pressure relief devices are located in, or connected to, the vapor space in either position.

(e) All container inlets and outlets, except pressure relief devices and gauging devices, shall be labeled to designate whether they communicate with the vapor or liquid space. Labels may be on valves.

(f) Containers from which only vapor is to be withdrawn shall be installed and equipped with suitable connections to minimize the possibility of the accidental withdrawal of liquid.

3-9.2.6 Regulators shall comply with 2-5.1 and 2-5.8 and shall be installed in accordance with 3-2.5. If in an enclosed space, the regulator relief device and the space above the regulator and relief device diaphragms shall be vented to the outside air. Such venting is not required if the regulator is located in a recess or cabinet as provided for in 3-9.2.2.

3-9.2.7 Piping shall comply with Section 2-4 as to material and design and shall be installed in accordance with 3-2.7, except that steel tubing shall have a minimum wall thickness of 0.049 in. Paragraphs 3-9.2.7(a) through (j) shall also apply to piping systems on vehicles covered by Section 3-9.

(a) A flexible connector or a tubing loop shall be installed between the regulator outlet and the piping system to protect against expansion, contraction, jarring and vibration strains.

(b) In the case of removable containers, flexibility shall be provided in the piping between the container and the gas piping system or regulator.

(c) Flexible connectors shall comply with 2-4.6 and be installed in accordance with 3-2.7.8(a). Flexible connectors of more than 36 in. (914.4 mm) overall length, or fuel lines of essentially all hose, shall be used only with the approval of the authority having jursidiction.

(d) The piping system shall be designed, installed, supported and secured in such a manner as to minimize the possibility of damage due to vibration, strains or wear, and to preclude any working loose while in transit.

(e) Piping (including hose) shall be installed in a protected location. If outside, piping shall be under the vehicle and below any insulation or false bottom. Fastening or other protection shall be installed to prevent damage due to vibration or abrasion. At each point where piping passes through sheet metal or a structural member, a rubber grommet or equivalent protection shall be installed to prevent chaffing.

(f) Gas piping shall be installed to enter the vehicle through the floor directly beneath, or adjacent to, the appliance served. If a branch line is required, the tee connection shall be in the main gas line under the floor and outside the vehicle.

(g) Exposed parts of the piping system shall either be of corrosion-resistant material or adequately protected against exterior corrosion.

(h) Hydrostatic relief valves, complying with 2-4.7.1, shall be installed in isolated sections of liquid piping as provided in 3-2.8.

(i) Piping systems, including hose, shall be tested and proven free of leaks in accordance with 3-2.9.

(j) There shall be no fuel connection between a tractor and trailer or other vehicle units.

3-9.3 Equipment Installation.

3-9.3.1 Equipment for installation on vehicles shall comply with Section 2-5 as to design and construction, and shall be installed in accordance with 3-2.10, and with the following:

(a) Installation shall be made in accordance with the manufacturer's recommendations and, in the case of listed or approved equipment, as provided in the listing or approval.

(b) Equipment installed on vehicles shall be considered as part of the LP-Gas system on the vehicle and shall be protected against vehicular damage as provided for container appurtenances and connections in 3-9.2.3(c).

3-9.4 Appliance Installation.

3-9.4.1 The term "appliances" as used in this subsection shall include any commercial or industrial gas consuming device except engines.

3-9.4.2 All gas consuming devices (appliances), other than engines, installed on vehicles shall be approved as provided in 2-6.2, shall comply with 2-6.3, and shall be installed as follows:

(a) Whenever the device or appliance is of a type designed to be in operation while the vehicle is in transit, such as a cargo heater or cooler, suitable means to stop the flow of gas in the event of a line break, such as an excess-flow valve, shall be installed. Excess-flow valves shall comply with 2-4.5.3 and 2-3.3.3(b).

(b) All gas-fired heating appliances shall be equipped with safety shutoffs in accordance with 2-6.3.5(a) except those covered in 3-4.2.7(b).

(c) For installations on vehicles intended for human occupancy, all gas-fired heating appliances, except ranges and illuminating appliances, shall be designed or installed to provide for a complete separation of the combustion system from the atmosphere inside the vehicle. Combustion air inlets and flue gas outlets shall be listed or certified as components of the appliance.

(d) For installations on vehicles not intended for human occupancy, unvented-type gas-fired heating appliances may be used to protect the cargo. Provision shall be made to provide air for combustion [*see 3-9.4.2(f)*] and to dispose of the products of combustion to the outside.

(e) Appliances installed within vehicles shall comply with the following:

(1) If in the cargo space, they shall be located so as to be readily accessible whether the vehicle is loaded or empty.

(2) Appliances shall be so constructed or otherwise protected as to minimize possible damage or impaired operation due to cargo shifting or handling.

(3) Appliances shall be located so that a fire at any appliance will not block egress of persons from the vehicle.

(f) Provision shall be made in all appliance installations to ensure an adequate supply of outside air for combustion.

(g) A permanent caution plate shall be provided, affixed either to the appliance, or to the vehicle outside of any enclosure and adjacent to the container(s), including the following items:

CAUTION

(1) Be sure all appliance valves are closed before opening container valve.

(2) Connections at the appliances, regulators and containers shall be checked periodically for leaks with soapy water or its equivalent.

(3) Never use a match or flame to check for leaks.

(4) Container valves shall be closed when equipment is not in use.

3-9.5 General Precautions.

3-9.5.1 Containers on vehicles shall be filled or refilled as provided by 4-2.2.2. See 2-2.1.3 for requalification requirements for continued use or reinstallation.

3-9.5.2 Mobile units containing hotplates and other cooking equipment, including mobile kitchens and catering vehicles, shall be provided with at least one approved portable fire extinguisher rated in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*, at not less than 10-B:C.

3-10 Fire Protection.

3-10.1 Application.

3-10.1.1 This section includes provisions for fire protection to augment the leak control and ignition source control provisions in this standard.

3-10.2 General.

3-10.2.1 The wide range in size, arrangement and location of LP-Gas installations covered by this standard precludes the inclusion of detailed fire protection provisions completely applicable to all installations. Provisions in this section are subject to verification or modification through analysis of local conditions.

3-10.2.2 The planning for effective measures for control of inadvertent LP-Gas release or fire shall be coordinated with local emergency handling agencies, such as fire and police departments. Such measures require specialized knowledge and training not commonly present in the training programs of emergency handling agencies.[1] Planning shall consider the safety of emergency personnel.

3-10.2.3 Except as provided in 3-10.2.4 or 3-10.2.5, fire protection shall be provided for installations having storage containers with an aggregate water capacity of more than 4000 gal (15 m^3) subject to exposure from a single fire. The mode of such protection shall be arrived at through competent fire safety analysis of local conditions of hazard within the container site, exposure to or from other properties, water supply, the probable effectiveness of plant fire brigades, and the time of response and probable effectiveness of fire departments. (*See 3-2.2.7.*)

(a) The first consideration in such an analysis shall consist of the use of water applied by hose streams by the fire brigade or fire department for the effective control of hazardous leakage or fire exposing storage tanks, cargo vehicles, or railroad tank cars which may be present.

NOTE: Experience has indicated that hose stream application of water in adequate quantities as soon as possible after the initiation of flame contact is an effective way to prevent container failure from fire exposure. The majority of large containers exposed to sufficient fire to result in container failure have failed in from 10 to 30 minutes after the start of the fire when water was not applied. Water in the form of a spray can also be used to control unignited gas leakage.

3-10.2.4 If the analysis specified in 3-10.2.3 indicates a serious hazard does not exist, the fire protection provisions of 3-10.2.3 need not apply.

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[1] The National Fire Protection Association, American Petroleum Institute and National LP-Gas Association publish material, including visual aids, useful in such planning.

3-10.2.5 If the analysis specified in 3-10.2.3 indicates that a serious hazard exists and the provisions of 3-10.2.3 cannot be met, special protection (*see Definition*) shall be provided in accordance with 3-10.3.

3-10.2.6 Suitable roadways or other means of access for emergency equipment, such as fire department apparatus, shall be provided.

3-10.2.7 Each industrial plant, distributing plant and distributing point shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 20 lb of dry chemical with a B:C rating.

3-10.2.8 LP-Gas fires shall not normally be extinguished until the source of the burning gas has been shut off or can be shut off.

3-10.2.9 Emergency controls shall be conspicuously marked and the controls shall be located so as to be readily accessible in emergencies.

3-10.3 Special Protection.

3-10.3.1 If insulation is used[1], it shall be capable of limiting the container temperature to not over 800°F (427°C) for a minimum of 50 minutes as determined by test with insulation applied to a steel plate and subjected to a test flame substantially over the area of the test plate. The insulation system shall be inherently resistant to weathering and the action of hose streams[2].

3-10.3.2 If mounding is utilized, the provisions of 3-2.3.7 shall constitute adequate protection.

3-10.3.3 If burial is utilized, the provisions of 3-2.3.8 shall constitute adequate protection.

3-10.3.4 If water spray fixed systems are used, they shall comply with NFPA 15, *Water Spray Fixed Systems for Fire Protection*. Such systems shall be automatically actuated by fire responsive devices and also have a capability for manual actuation.

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[1] For LP-Gas fixed storage facilities of 60,000 gal (227 m^3) water capacity or less, a competent fire safety analysis (*see 3-10.2.3 and 3-10.2.5*) could indicate that applied insulating coatings are quite often the most practical solution for special protection.

[2] It is recommended that insulation systems be evaluated on the basis of experience or listings by an approved testing laboratory.

3-10.3.5 If monitor nozzles are used, they shall be located and arranged so that all container surfaces likely to be exposed to fire will be wetted. Such systems shall otherwise comply with NFPA 15, *Water Spray Fixed Systems for Fire Protection*, and shall be automatically actuated by fire responsive devices and also have a capability for manual actuation.

Chapter 4 LP-Gas Liquid Transfer

4-1 Scope.

4-1.1 Application.

4-1.1.1 This chapter covers transfers of liquid LP-Gas from one container to another whenever this transfer involves connections and disconnections in the transfer system, or the venting of LP-Gas to the atmosphere. Included are provisions covering operational safety, location of transfer operations and methods for determining the quantity of LP-Gas permitted in containers.

4-1.1.2 Provisions for ignition source control at transfer locations are covered in Section 3-8. Fire protection shall be in accordance with Section 3-10.

4-2 Operational Safety.

4-2.1 Transfer Personnel.

4-2.1.1 Transfer operations shall be conducted by competent personnel meeting the provisions of 1-6.1.1. At least one qualified person shall remain at or near the transfer operation from the time connections are made until the transfer is completed, shutoff valves are closed, and lines are disconnected.

4-2.1.2 Transfer personnel shall exercise precaution to assure that the LP-Gases transferred are those for which the transfer system and the containers to be filled are designed.

4-2.2 Containers to be Filled.

4-2.2.1 Containers shall be filled only by the owner or upon the owner's authorization.

4-2.2.2 Containers shall be filled only after determination that they comply with the design, fabrication, inspection, marking and requalification provisions of this standard. (*See 2-2.1.2, 2-2.1.3, and 2-2.1.4.*)

4-2.2.3 DOT specification cylinders authorized as "single trip," "nonrefillable," or "disposable" containers shall not be refilled with LP-Gas.

4-2.2.4 Containers into which LP-Gas is to be transferred shall comply with the following as to service or design pressure in relation to the vapor pressure of the LP-Gas:

(a) For DOT specification cylinders, the service pressure marked on the container shall not be less than 80 percent of the vapor pressure of the LP-Gas at 130°F (54.4°C). For example, if the vapor pressure of a commercial propane is 300 psig (2.0 MPa gauge) at 130°F (54.4°C), the service pressure must be at least 80 percent of 300, or 240 psig (1.6 MPa gauge).

(b) For ASME containers, the minimum design pressure shall comply with Table 2-2.2.2 in relation to the vapor pressure of the LP-Gas.

4-2.3 Arrangement and Operation of Transfer Systems.

4-2.3.1 Liquid transfer may be accomplished by pressure differential, by gravity or by the use of pumps or compressors complying with Section 2-5.

4-2.3.2 Compressors used for liquid transfer normally shall take suction from the vapor space of the container being filled and dicharge into the vapor space of the container from which the withdrawal is being made.

4-2.3.3 Transfer systems using positive displacement pumps shall comply with 2-5.2.2.

4-2.3.4 Transfer hose equipped with a shutoff valve at the discharge end, so that the hose normally contains liquid (called "wet hose" by the industry), shall be protected against excessive hydrostatic pressure by the use of hydrostatic relief valves. (*See 3-2.8.*)

NOTE: When hose is to be used for liquid transfer, this arrangement is recommended.

4-2.3.5 The provisions of 3-2.7.9 shall apply.

4-2.3.6 When a hose or swivel type piping is used for loading or unloading railroad tank cars, an emergency shutoff valve complying with 2-4.5.4 shall be used at the tank car end of the hose or swivel type piping.

4-2.3.7 Transfer hoses larger than ½ in. (12 mm) internal diameter shall not be used for making connections to individual containers being filled indoors.

4-2.3.8 During the time the tank cars are on sidings for loading or unloading, the following shall apply:

(a) A caution sign, such as "STOP. TANK CAR CONNECTED," shall be placed at the active end(s) of the siding while car is connected as required by DOT Regulations.

(b) A wheel at each end of car shall be blocked on the rails.

4-3 Location of Transfer Operations.

4-3.1 General.

4-3.1.1 Liquid shall be transferred into containers, including containers mounted on vehicles, only outdoors or in structures especially designed for this purpose.

(a) Structures housing transfer operations or converted for such use after December 31, 1972 shall comply with Chapter 7.

(b) The transfer of liquid into containers on the roofs of structures is prohibited.

4-3.2 Containers in Stationary Installations.

4-3.2.1 Containers located outdoors in stationary installations (*see definition*) in accordance with Section 3-2, and equipped with appurtenances for filling at, or adjacent to, the container may be filled at that location, provided that a cargo vehicle is used for the delivery which complies with Chapter 6 as to construction and method of operation.

4-3.2.2 If the point of transfer (*see definition*) is not located at the container, it shall be located in accordance with 4-3.3.

4-3.3 Containers in Nonstationary Installations.

4-3.3.1 This subsection includes provisions for filling of portable containers not a part of a stationary installation (*see definition*), including containers mounted on vehicles (including recreational vehicles) and industrial and agricultural equipment.

4-3.3.2 The point of transfer (*see definition*) or the nearest part of a structure housing transfer operations, whichever is closer, shall be located in accordance with Table 4-3.3.2 with respect to various types of exposures.

(a) If the point of transfer is a component of a system covered by Sections 3-6 or 3-9 or part of a system installed in accordance with standards referenced in 3-1.1.3, Parts 1, 2 and 3 of Table 4-3.3.2 do not apply to the structure containing the point of transfer.

(b) If LP-Gas is vented to the atmosphere under the conditions stipulated in 4-4.1.1(d), the distances in Table 4-3.3.2 shall be doubled.

(c) If the point of transfer is housed in a structure complying with Chapter 7, the distances in Table 4-3.3.2 may be reduced provided either the exposing wall(s) or the exposed wall(s) complies with 7-3.1.1(a).

Table 4-3.3.2[1]

Distance Between Point of Transfer and Exposures

Part	Exposure	Min. Horizontal Distance, Feet (Meters)
1.	Buildings[2] with fire resistive walls[3]	10 (3)
2.	Buildings[2] with other than fire resistive walls	25 (7.6)
3.	Building wall openings or pits at or below the level of the point of transfer	25 (7.6)
4.	Line of adjoining property which can be built upon	25 (7.6)
5.	Outdoor places of public assembly, including school yards, athletic fields and playgrounds	50 (15)
6.	Public ways, including public streets, highways, thoroughfares and sidewalks	
	(a) From points of transfer in Distributing Points	10 (3)
	(b) From points of transfer in all other locations	25 (7.6)
7.	Driveways	5 (1.5)
8.	Mainline railroad track centerlines	25 (7.6)
9.	Containers[4] other than those being filled	10 (3)

[1] Table 4-3.3.2 is not applicable to the transfer operations covered in 4-3.2.1.

[2] "Buildings," for the purpose of this Table, include structures such as mobile homes, recreational vehicles, modular homes, tents and box trailers at construction sites.

[3] Walls constructed of noncombustible materials having, as erected, a fire resistance of at least one hour as determined by NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

[4] Not applicable to filling connections at the storage container or to dispensing units of 2000 gal (7.6 m^3) water capacity or less when used for filling containers not mounted upon vehicles.

4-3.4 Cargo Vehicles.

4-3.4.1 Cargo vehicles (*see Section 6-3*) unloading into storage containers shall be at least 10 ft (3 m) from the container and so positioned that the shutoff valves on both the truck and the container are readily accessible. In the case of distributing points, such as LP-Gas service stations, the truck or transport shall not be parked on a public way.

4-4 Venting LP-Gas to the Atmosphere.

4-4.1 General.

4-4.1.1 LP-Gas, in either liquid or vapor form, normally shall not be vented to the atmosphere except under the following conditions:

(a) Venting for the operation of fixed liquid level, rotary or slip tube gauges, provided the maximum flow does not exceed that from a No. 54 drill orifice.

(b) Venting the LP-Gas between shutoff valves before disconnecting the liquid transfer line from the container. When necessary, suitable bleeder valves shall be used.

(c) LP-Gas may be vented for the purposes described in 4-4.1.1(a) and (b) within structures designed for container filling as provided in 4-3.1.1 and Chapter 7.

(d) Venting vapor from listed liquid transfer pumps using such vapor as a source of energy, provided the rate of discharge does not exceed that from a No. 31 drill size opening. (*See 4-3.3.2 as to location of such transfer operations.*)

4-4.2 Purging.

4-4.2.1 Venting of gas from containers for purging or for other purposes shall be accomplished as follows:

(a) If indoors, containers may be vented only in structures designed and constructed for container filling in accordance with 4-3.1.1 and Chapter 7 and with the following provisions:

(1) Piping shall be provided to carry the vented product outside and to a point at least 3 ft (1 m) above the highest point of any building within 25 ft (7.6 m).

(2) Only vapors shall be exhausted to the atmosphere.

(3) If a vent manifold is used to allow for the venting of more than one container at a time, each connection to the vent manifold shall be equipped with a back-flow check valve.

(b) When out of doors, container venting shall be done under conditions that will result in rapid dispersion of the product being released. Consideration shall be given to such factors as distance to buildings, terrain, wind direction and velocity, and use of a vent stock so that a flammable mixture will not reach a point of ignition.

(c) If conditions are such that venting into the atmosphere cannot be accomplished safely, LP-Gas may be burned off providing such burning is done under controlled conditions remote from combustibles or a hazardous atmosphere.

4-4.3 Emergency Venting.

4-4.3.1 The procedure to be followed for the disposal of LP-Gas in an emergency will be dictated by the conditions present, requiring individual judgment in each case and using, where practical, the provisions of this standard.

4-5 Quantity of LP-Gas in Containers.

4-5.1 Application.

4-5.1.1 This section includes provisions covering the maximum permissible LP-Gas content of containers and the methods of verifying this quantity.

4-5.2 LP-Gas Capacity of Containers (*see Appendix E*).

4-5.2.1 The maximum LP-Gas content of any container shall be that quantity which equals the maximum permitted filling density given in Table 4-5.2.1.

Table 4-5.2.1

Maximum Permitted Filling Density

	Aboveground Containers		
Specific Gravity at 60°F (15.6°C)	0 to 1200 US Gal (1000 Imp. gal, 4.5 m³) Total Water Cap.	Over 1200 US Gal (1000 Imp. gal, 4.5 m³) Total Water Cap.	Underground Containers all Capacities
.496-.503	41%	44%	45%
.504-.510	42	45	46
.511-.519	43	46	47
.520-.527	44	47	48
.528-.536	45	48	49
.537-.544	46	49	50
.545-.552	47	50	51
.553-.560	48	51	52
.561-.568	49	52	53
.569-.576	50	53	54
.577-.584	51	54	55
.585-.592	52	55	56
.593-.600	53	56	57

4-5.2.2 Filling density is defined as the ratio of the weight of LP-Gas in a container to the weight of water at 60°F (15.6°C) that the container will hold. The maximum permitted filling density shown in Table 4-5.2.1 is in percent of the water weight capacity (WWC) for the specific gravity of the particular LP-Gas, the size of the container and the container location.

4-5.2.3 Determination that the LP-Gas content of a container complies with Table 4-5.2.1 may be either by weight or by volume in accordance with 4-5.3. If by volume, the volume having a weight equal to the maximum permitted filling density shall be calculated by the formula in 4-5.2.3(b). These equivalent volumes are shown in Tables 4-5.2.3(a), (b) and (c).

(a) The maximum liquid LP-Gas content of any container depends upon the size of the container, whether it is installed aboveground or underground, the maximum permitted filling density and the temperature of the liquid [*See Tables 4-5.2.3(a), (b) and (c)*].

(b) The maximum volume "V_t," (in percent of container capacity) of an LP-Gas at temperature "t," having a specific gravity "G" and a filling density of "L," shall be computed by use of the formula (*see Appendix E,* E-4.1.2 for example):

$$V_t = \frac{L}{G} \div F, \text{ or } V_t = \frac{L}{G \times F} \text{ where:}$$

V_t = percent of container capacity which may be filled with liquid.

L = filling density.

G = specific gravity of particular LP-Gas.

F = correction factor to correct volume at temperature "t" to 60°F (15.6°C).

4-5.3 Compliance with Maximum Permitted Filling Density Provisions.

4-5.3.1 The maximum permitted filling density for any container, where practical, may be determined by weight.

4-5.3.2 The volumetric method may be used for the following containers if designed and equipped for filling by volume:

(a) DOT specification cylinders of less than 200 lb (91 kg) water capacity which are not subject to DOT jurisdiction (such as, but not limited to, motor fuel containers on vehicles not in interstate commerce or cylinders filled at the installation).

(b) DOT specifications cylinders of 200 lb (91 kg) water capacity or more. (*See DOT regulations requiring spot weight checks.*)

(c) Cargo tanks or portable tank containers complying with DOT Specifications MC-330, MC-331 or DOT 51.

(d) ASME and API-ASME containers complying with 2-2.1.3 or 2-2.2.2.

4-5.3.3 When the volumetric method is used, it shall be in accordance with 4-5.3.3(a) through (c).

(a) If a maximum fixed liquid level gauge, or a variable liquid level gauge without liquid volume temperature correction is used, the liquid level indicated by these gauges must be computed on the basis of the maximum permitted filling density when the liquid is at 40°F (4.4°C) for aboveground containers or at 50°F (10°C) for underground containers.

(b) When a variable liquid level gauge is used and the liquid volume is corrected for temperature, the maximum permitted liquid level shall be in accordance with Tables 4-5.2.3(a), (b) and (c).

(c) In the case of containers fabricated after December 31, 1965 with a water capacity of 2,000 gal (7.6 m^3) or less and which are filled at consumer sites, gauging shall comply with the following:

(1) The variable gauge shall have been checked for accuracy by comparison with the liquid level indicated by the fixed maximum liquid level gauge.

(2) If the container is to be filled beyond the level indicated by the fixed maximum liquid level gauge, the reading of the variable gauge, adjusted for the error indicated by the check with the fixed maximum liquid level gauge, shall be corrected for the LP-Gas liquid temperature.

4-5.3.4 When containers are to be filled volumetrically by a variable liquid level gauge in accordance with 4-5.3.3(b), provisions shall be made for determining the liquid temperature (*see E-3.1.2*).

Table 4-5.2.3(a)

MAXIMUM PERMITTED LIQUID VOLUME

(Percent of Total Water Capacity)

	Aboveground Containers 0 to 1200 Gallons (0 to 4.5 m^3)												
	Specific Gravity												
Liquid Temperature °F (°C)	.496 to .503	.504 to .510	.511 to .519	.520 to .527	.528 to .536	.537 to .544	.545 to .552	.553 to .560	.561 to .568	.569 to .576	.577 to .584	.585 to .592	.593 to .600
−50 (−45.6)	70	71	72	73	74	75	75	76	77	78	79	79	80
−45 (−42.8)	71	72	73	73	74	75	76	77	77	78	79	80	80
−40 (−40)	71	72	73	74	75	75	76	77	78	79	79	80	81
−35 (−37.2)	71	72	73	74	75	76	77	77	78	79	80	80	81
−30 (−34.4)	72	73	74	75	76	76	77	78	78	79	80	81	81
−25 (−31.5)	72	73	74	75	76	77	77	78	79	80	80	81	82
−20 (−28.9)	73	74	75	76	76	77	78	79	79	80	81	81	82
−15 (−26.1)	73	74	75	76	77	77	78	79	80	80	81	82	83
−10 (−23.3)	74	75	76	76	77	78	79	79	80	81	81	82	83
− 5 (−20.6)	74	75	76	77	78	78	79	80	80	81	82	82	83
0 (−17.8)	75	76	76	77	78	79	79	80	81	81	82	83	84
5 (−15)	75	76	77	78	78	79	80	81	81	82	83	83	84
10 (−12.2)	76	77	77	78	79	80	80	81	82	82	83	84	84
15 (−9.4)	76	77	78	79	80	80	81	81	82	83	83	84	85
20 (−6.7)	77	78	78	79	80	80	81	82	83	84	84	84	85

25 (−3.9)	77	78	79	80	80	81	82	82	83	84	84	85	85
30 (−1.1)	78	79	79	80	81	81	82	83	83	84	85	85	86
35 (1.7)	78	79	80	81	81	82	83	83	84	85	85	86	86
*40 (4.4)	79	80	81	81	82	82	83	84	84	85	86	86	87
45 (7.8)	80	80	81	82	82	83	84	84	85	85	86	87	87
50 (10)	80	81	82	82	83	83	84	85	85	86	86	87	88
55 (12.8)	81	82	82	83	84	84	85	85	86	86	87	87	88
60 (15.6)	82	82	83	84	84	85	85	86	86	87	87	88	88
65 (18.3)	82	83	84	84	85	85	86	86	87	87	88	88	89
70 (21.1)	83	84	84	85	85	86	86	87	87	88	88	89	89
75 (23.9)	84	85	85	85	86	86	87	87	88	88	89	89	90
80 (26.7)	85	85	86	86	87	87	87	88	88	89	89	90	90
85 (29.4)	85	86	87	87	88	88	88	89	89	89	90	90	91
90 (32.2)	86	87	87	88	88	88	89	89	90	90	90	91	91
95 (35)	87	88	88	88	89	89	89	90	90	91	91	91	92
100 (37.8)	88	89	89	89	89	90	90	90	91	91	92	92	92
105 (40.4)	89	89	90	90	90	90	91	91	91	92	92	92	93
110 (43)	90	90	91	91	91	91	92	92	92	92	93	93	93
115 (46)	91	91	92	92	92	92	92	92	93	93	93	94	94
120 (49)	92	92	93	93	93	93	93	93	93	94	94	94	94
125 (51.5)	93	94	94	94	94	94	94	94	94	94	94	95	95
130 (54)	94	95	95	95	95	95	95	95	95	95	95	95	95

*See 4-5.3.3(a).

Table 4-5.2.3(b)

MAXIMUM PERMITTED LIQUID VOLUME

(Percent of Total Water Capacity)

Liquid Temperature °F (°C)	Aboveground Containers Over 1200 Gallons (4.5 m^3)												
	Specific Gravity												
	.496 to .503	.504 to .510	.511 to .519	.520 to .527	.528 to .536	.537 to .544	.545 to .552	.553 to .560	.561 to .568	.569 to .576	.577 to .584	.585 to .592	.593 to .600
−50 (−45.6)	75	76	77	78	79	80	80	81	82	83	83	84	85
−45 (−42.8)	76	77	78	78	79	80	81	81	82	83	84	84	85
−40 (−40)	76	77	78	79	80	80	81	82	83	83	84	85	85
−35 (−37.2)	77	78	78	79	80	81	82	82	83	84	84	85	86
−30 (−34.4)	77	78	79	80	80	81	82	83	83	84	85	85	86
−25 (−31.5)	78	79	79	80	81	82	82	83	84	84	85	86	86
−20 (−28.9)	78	79	80	81	81	82	83	83	84	85	85	86	87
−15 (−26.1)	79	79	80	81	82	82	83	84	85	85	86	87	87
−10 (−23.3)	79	80	81	82	82	83	84	84	85	86	86	87	87
− 5 (−20.6)	80	81	81	82	83	83	84	85	85	86	87	87	88
0 (−17.8)	80	81	82	82	83	84	84	85	86	86	87	88	88
5 (−15)	81	82	82	83	84	84	85	86	86	87	87	88	89
10 (−12.2)	81	82	83	83	84	85	85	86	87	87	88	88	89
15 (−9.4)	82	83	83	84	85	85	86	87	87	88	88	89	90
20 (−6.7)	82	83	84	85	85	86	86	87	88	88	89	89	90

25 (−3.9)	83	84	84	85	86	86	87	88	88	89	89	90	90
30 (−1.1)	83	84	85	86	86	87	87	88	89	89	90	90	91
35 (1.7)	84	85	86	86	87	87	88	89	89	90	90	91	91
*40 (4.4)	85	86	86	87	87	88	88	89	90	90	91	91	92
45 (7.8)	85	86	87	87	88	88	89	89	90	91	91	92	92
50 (10)	86	87	87	88	88	89	90	90	91	91	92	92	92
55 (12.8)	87	88	88	89	89	90	90	91	91	92	92	92	93
60 (15.6)	88	88	89	89	90	90	91	91	92	92	93	93	93
65 (18.3)	88	89	90	90	91	91	91	92	92	93	93	93	94
70 (21.1)	89	90	90	91	91	91	92	92	93	93	94	94	94
75 (23.9)	90	91	91	91	92	92	92	93	93	94	94	94	95
80 (26.7)	91	91	92	92	92	93	93	93	94	94	95	95	95
85 (29.4)	92	92	93	93	93	93	94	94	95	95	95	96	96
90 (32.2)	93	93	93	94	94	94	95	95	95	95	96	96	96
95 (35)	94	94	94	95	95	95	95	96	96	96	96	97	97
100 (37.8)	94	95	95	95	95	96	96	96	96	97	97	97	98
105 (40.4)	96	96	96	96	96	97	97	97	97	97	98	98	98
110 (43)	97	97	97	97	97	97	97	98	98	98	98	98	99
115 (46)	98	98	98	98	98	98	98	98	98	99	99	99	99

*See 4-5.3.3(a).

Table 4-5.2.3(c)

MAXIMUM PERMITTED LIQUID VOLUME

(Percent of Total Water Capacity)

	All Underground Containers												
	Specific Gravity												
Liquid Temperature °F (°C)	.496 to .503	.504 to .510	.511 to .519	.520 to .527	.528 to .536	.537 to .544	.545 to .552	.553 to .560	.561 to .568	.569 to .576	.577 to .584	.585 to .592	.593 to .600
− 50 (− 45.6)	77	78	79	80	80	81	82	83	83	84	85	85	86
− 45 (− 42.8)	77	78	79	80	81	82	82	83	84	84	85	86	87
− 40 (− 40)	78	79	80	81	81	82	83	83	84	85	86	86	87
− 35 (− 37.2)	78	79	80	81	82	82	83	84	85	85	86	87	87
− 30 (− 34.4)	79	80	81	81	82	83	84	84	85	86	86	87	88
− 25 (− 31.5)	79	80	81	82	83	83	84	85	85	86	87	87	88
− 20 (− 28.9)	80	81	82	82	83	84	84	85	86	86	87	88	88
− 15 (− 26.1)	80	81	82	83	84	84	85	86	86	87	87	88	89
− 10 (− 23.3)	81	82	83	83	84	85	85	86	87	87	88	88	89
− 5 (− 20.6)	81	82	83	84	84	85	86	86	87	88	88	89	89
0 (− 17.8)	82	83	84	84	85	85	86	87	87	88	89	89	90
5 (− 15)	82	83	84	85	85	86	87	87	88	88	89	90	90
10 (− 12.2)	83	84	85	85	86	86	87	88	88	89	90	90	91
15 (− 9.4)	84	84	85	86	86	87	88	88	89	89	90	91	91
20 (− 6.7)	84	85	86	86	87	88	88	89	89	90	90	91	91

25 (− 3.9)	85	86	86	87	87	88	89	89	90	90	91	91	92
30 (− 1.1)	85	86	87	87	88	89	89	90	90	91	91	92	92
35 (1.7)	86	87	87	88	88	89	90	90	91	91	92	92	93
40 (4.4)	87	87	88	88	89	90	90	91	91	92	92	93	93
45 (7.8)	87	88	89	89	90	90	91	91	92	92	93	93	94
*50 (10)	88	89	89	90	90	91	91	92	92	93	93	94	94
55 (12.8)	89	89	90	91	91	91	92	92	93	93	94	94	95
60 (15.6)	90	90	91	91	92	92	92	93	93	94	94	95	95
65 (18.3)	90	91	91	92	92	93	93	94	94	94	95	95	96
70 (21.1)	91	91	92	93	93	93	94	94	94	95	95	96	96
75 (23.9)	92	93	93	93	94	94	94	95	95	95	96	96	97
80 (26.7)	93	93	94	94	94	95	95	95	96	96	96	97	97
85 (29.4)	94	94	95	95	95	95	96	96	96	97	97	97	98
90 (32.2)	95	95	95	95	96	96	96	97	97	97	98	98	98
95 (35)	96	96	96	96	97	97	97	97	98	98	98	98	99
100 (37.8)	97	97	97	97	97	98	98	98	98	99	99	99	99
105 (40.4)	98	98	98	98	98	98	99	99	99	99	99	99	99

*See 4-5.3.3(a).

Chapter 5 Storage of Portable Containers Awaiting Use or Resale

5-1 Scope.

5-1.1 Application.

5-1.1.1 The provisions of this chapter are applicable to the storage of portable containers of 1,000 lb (454 kg) water capacity, or less, whether filled, partially filled or empty (if they have been in LP-Gas service) as follows:

(a) At consumer sites or distributing points, but not connected for use.

(b) In storage for resale by dealer or reseller.

5-1.1.2 The provisions of this chapter do not apply to:

(a) Containers stored at distributing plants.

5-2 General Provisions.

5-2.1 General Location of Containers.

5-2.1.1 Containers in storage shall be so located as to minimize exposure to excessive temperature rise, physical damage or tampering.

5-2.1.2 Containers in storage having individual water capacity greater than 2½ lb (1 kg) [nominal one pound (0.45kg) LP-Gas capacity] shall be positioned such that the pressure relief valve is in direct communication with the vapor space of the container.

5-2.1.3 Containers stored in buildings in accordance with Section 5-3 shall not be located near exits, stairways, or in areas normally used, or intended to be used, for the safe egress of people.

5-2.1.4 Empty containers which have been in LP-Gas service shall preferably be stored in the open. If stored inside, they shall be considered as full containers for the purposes of determining the maximum quantities of LP-Gas permitted in 5-3.1.1, 5-3.2.1, and 5-3.3.1.

5-2.1.5 Containers not connected for use shall not be stored on roofs.

5-2.2 Protection of Valves on Containers in Storage.

5-2.2.1 Container valves shall be protected as required by 2-2.4.1. Screw-on type caps or collars shall be securely in place on all containers stored regardless of whether they are full, partially full or empty, and container outlet valves shall be closed or plugged.

5-3 Storage Within Buildings.

5-3.1 Storage within Buildings Frequented by the Public.

5-3.1.1 DOT specification cylinders with a maximum water capacity of 2½ lb (1 kg), used with completely self-contained hand torches and similar applications, may be stored or displayed in a building frequented by the public. The quantity of LP-Gas shall not exceed 200 lb (91 kg) except as provided in 5-3.3.

5-3.2 Storage within Buildings Not Frequented by the Public (such as industrial buildings).

5-3.2.1 The maximum quantity allowed in one storage location shall not exceed 735 lb (334 kg) water capacity [nominal 300 lb (136 kg) LP-Gas]. If additional storage locations are required on the same floor within the same building, they shall be separated by a minimum of 300 ft (91 m). Storage beyond these limitations shall comply with 5-3.3

5-3.2.2 Containers carried as a part of the service equipment on highway mobile vehicles are not to be considered in the total storage capacity in 5-3.2.1 provided such vehicles are stored in private garages and carry only one LP-Gas container with an LP-Gas capacity of 100 lb (45 kg) or less per vehicle. Container valves shall be closed.

5-3.3 Storage within Special Buildings or Rooms.

5-3.3.1 The maximum quantity of LP-Gas which may be stored in special buildings or rooms shall be 10,000 lb (4540 kg).

5-3.3.2 Special buildings or rooms for storing LP-Gas containers shall not be located adjoining the line of property occupied by schools, churches, hospitals, athletic fields or other points of public gathering.

5-3.3.3 The construction of all such special buildings, and rooms within, or attached to, other buildings, shall comply with Chapter 7 and the following:

(a) Adequate vents, to the outside only, shall be provided at both top and bottom, located at least 5 ft (1.5 m) away from any building opening.

(b) The entire area shall be classified for purposes of ignition source control in accordance with Section 3-8.

5-4 Storage Outside of Buildings.

5-4.1 Location of Storage Outside of Buildings.

5-4.1.1 Storage outside of buildings, for containers awaiting use or resale, shall be located in accordance with Table 5-4.1.1 with respect to:

(a) Nearest important building or group of buildings.

(b) Line of adjoining property which may be built upon.

(c) Busy thoroughfares or sidewalks.

(d) Line of adjoining property occupied by schools, churches, hospitals, athletic fields or other points of public gathering.

Table 5-4.1.1

Quantity of LP-Gas Stored	Distance to: (a) and (b)	(c) and (d)
500 lb (227 kg) or less	0	0
501 (227+ kg) to 2,500 lb (1134 kg)	0	10 ft (3 m)
2,501 (1134+ kg) to 6,000 lb (2721 kg)	10 ft (3 m)	10 ft (3 m)
6,001 (1721+ kg) to 10,000 lb (4540 kg)	20 ft (6 m)	20 ft (6 m)
Over 10,000 lb (4540 kg)	25 ft (7.6 m)	25 ft (7.6 m)

5-4.2 Protection of Containers.

5-4.2.1 Containers shall be stored within a suitable enclosure or otherwise protected against tampering.

5-4.3 Alternate Location and Protection of Storage.

5-4.3.1 When the provisions of 5-4.1.1 and 5-4.2.1 are impractical at construction sites, or at buildings or structures undergoing major renovation or repairs, the storage of containers shall be acceptable to the authority having jurisdiction.

5-5 Fire Protection.

5-5.1 Fire Extinguisher Requirements.

5-5.1.1 Storage locations, other than supply depots at separate locations apart from those of the dealer, reseller or user's establishments, shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 20 lb dry chemical with a B:C rating. (*Also see NFPA 10.*)

Chapter 6 Vehicular Transportation of LP-Gas

6-1 Scope.

6-1.1 Application.

6-1.1.1 This chapter includes provisions applying to containers, container appurtenances, piping, valves, equipment and vehicles used in the transportation of LP-Gas, as follows:

(a) Transportation of portable containers.

Exception: The provisions of this chapter are not applicable to LP-Gas containers and related equipment incident to their use on vehicles as covered in Sections 3-6 and 3-9.

(b) Transportation in cargo vehicles, whether fabricated by mounting cargo tanks on conventional truck or trailer chassis, or constructed as integral cargo units in which the container constitutes in whole, or in part, the stress member of the vehicle frame. Transfer equipment and piping, and the protection of such equipment and the container appurtenances against overturn, collision or other vehicular accidents are also included.

(c) Most truck transportation of LP-Gas is subject to regulation by the US Department of Transportation. Many of the provisions of this chapter are identical or similar to DOT Regulations and are intended to extend these provisions to areas not subject to DOT regulation. Vehicles and procedures under the jurisdiction of DOT shall comply with DOT Regulations.

6-1.1.2 The provisions of this chapter are not applicable to the transportation of LP-Gas on vehicles incident to its use on these vehicles as covered in 3-6.4, 3-6.5, 3-6.6 and Section 3-9.

6-1.1.3 If LP-Gas is used for engine fuel, the supply piping and regulating, vaporizing, gas-air mixing and carburetion equipment, shall be designed, constructed and installed in accordance with Section 3-6. Fuel systems (including fuel containers) shall be constructed and installed in accordance with Section 3-9. Fuel may be used from the cargo tank of tank trucks, but not from cargo tanks on trailers or semitrailers.

6-1.1.4 No artificial light other than electrical shall be used with the vehicles covered by this chapter. Wiring used shall have adequate mechanical strength and current-carrying capacity with suitable overcurrent protection (fuses or automatic circuit breakers) and shall be properly insulated and protected against physical damage.

6-2 Transportation in Portable Containers.

6-2.1 Application.

6-2.1.1 This section applies to the vehicular transportation of portable containers filled with LP-Gas delivered as "packages," including containers built to DOT Cylinder specifications and of other portable containers (such as DOT portable tank containers and skid tanks). The design and construction of these containers is covered in Chapter 2.

6-2.2 Transportation of DOT Specification Cylinders or Portable ASME Containers.

6-2.2.1 Portable containers having an individual water capacity not exceeding 1,000 lb (454 kg) [nominal 420 lb (191 kg) LP-Gas capacity], when filled with LP-Gas, shall be transported in accordance with 6-2.2.2 through 6-2.2.9

6-2.2.2 Containers shall be constructed as provided in Section 2-2 and equipped in accordance with Section 2-3 for transportation as portable containers.

6-2.2.3 The quantity of LP-Gas in containers shall be in accordance with Chapter 4.

6-2.2.4 Valves of containers shall be protected in accordance with 2-2.4.1. Screw-on type protecting caps or collars shall be secured in place.

6-2.2.5 The cargo space of the vehicle shall be isolated from the driver's compartment, the engine and its exhaust system, except as provided in 6-2.2.5(a). Open-bodied vehicles shall be considered as in compliance with this provision. Closed-bodied vehicles having separate cargo, driver's and engine compartments shall be considered as in compliance with this provision.

(a) Closed-bodied vehicles such as passenger cars, vans and station wagons shall not be used for transporting more than 215 lb (98 kg) water capacity [nominal 90 lb (41 kg) LP-Gas capacity] but not more than 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) LP-Gas capacity] per container (*see 6-2.2.6 and 6-2.2.7*), unless the driver's and engine compartments are separated from the cargo space by a vapor-tight partition which contains no means of access to the cargo space.

6-2.2.6 Containers and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Containers shall be loaded into vehicles with substantially flat floors or equipped with suitable racks for holding containers. Containers shall be securely fastened in position to minimize the possibility of movement, tipping over or physical damage.

6-2.2.7 Containers having an individual water capacity exceeding 108 lb (49 kg) [nominal 45 lb (20 kg) LP-Gas capacity] transported in open vehicles shall be transported with the relief devices in direct communication with the vapor spaces. Containers having an individual water capacity exceeding 10 lb (4.5 kg) [nominal 4.2 lb (2 kg) LP-Gas capacity] transported in enclosed spaces of the vehicle shall be transported with the relief device in direct communication with the vapor spaces.

6-2.2.8 Containers having an individual water capacity not exceeding 108 lb (49 kg) [nominal 45 lb (20 kg) LP-Gas capacity] transported in open vehicles may be transported in other than the upright position. Containers having an individual water capacity not exceeding 10 lb (4.5 kg) [nominal 4.2 lb (2 kg) LP-Gas capacity] transported in enclosed spaces of the vehicle may be transported in other than the upright position.

6-2.2.9 Vehicles transporting more than 1,000 lb (454 kg) of LP-Gas, including the weight of the containers, shall be placarded as required by DOT regulations and/or state law.

6-2.3 Transportation of Portable Containers of More than 1,000 lb (454 kg) Water Capacity.

6-2.3.1 Portable containers having an individual water capacity exceeding 1000 lb (454 kg) [nominal 420 lb (191 kg) LP-Gas capacity] when filled with LP-Gas shall be transported in compliance with 6-2.3.2 through 6-2.3.9.

6-2.3.2 Containers shall be constructed in accordance with Section 2-2 and equipped in accordance with Section 2-3 for portable use, or shall comply with DOT portable tank container specifications for LP-Gas service.

6-2.3.3 The quantity of LP-Gas put into containers shall be in accordance with Chapter 4.

6-2.3.4 Valves and other container appurtenances shall be protected in accordance with 2-2.4.2.

6-2.3.5 Containers and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Containers shall be loaded into vehicles with substantially flat floors or equipped with suitable racks for holding containers. Containers shall be securely fastened in position to minimize the possibility of movement, tipping over or physical damage.

6-2.3.6 Containers and their appurtenances shall be determined to be leak-free before being loaded into vehicles. Containers shall be loaded onto a flat vehicle floor or platform, or onto a suitable vehicle frame. In either case, containers shall be securely blocked or held down to minimize movement, relative to each other or to the supporting structure, while in transit.

6-2.3.7 Containers shall be transported with relief devices in communication with the vapor space.

6-2.3.8 Vehicles carrying more than 1,000 lb (454 kg) of LP-Gas, including the weight of the containers, shall be placarded as required by DOT regulations and/or state law.

6-2.3.9 When portable containers complying with 6-2.3.1 through 6-2.3.8 are permanently or semipermanently mounted on vehicles to serve as cargo tanks, so that the assembled vehicular unit can be used for making liquid deliveries to other containers at points of use, the provisions of Section 6-3 shall apply.

6-2.4 Fire Extinguishers.

6-2.4.1 Each truck or trailer transporting portable containers as provided by 6-2.2 or 6-2.3 shall be equipped with at least one approved portable fire extinguisher having a minimum capacity of 20 lb dry chemical with a B:C rating. (*Also see NFPA 10.*)

6-3 Transportation in Cargo Vehicles.

6-3.1 Application.

6-3.1.1 This section includes provisions for cargo vehicles used for the transportation of LP-Gas as liquid cargo, normally loaded into the cargo container at the distributing or manufacturing point, and transferred into other containers at the point of delivery. Transfer may be made by a pump or compressor mounted on the vehicle or by a transfer means at the delivery point.

6-3.1.2 All LP-Gas cargo vehicles, whether used in interstate or intrastate service, shall comply with US Department of Transportation Requirements as specified in the Code of Federal Regulations, CFR 49, and to the Federal Motor Carrier Safety Regulations, Sections 393 and 397, and shall also comply with the added requirements of this standard.

6-3.2 Containers Mounted on, or a Part of, Cargo Vehicles.

6-3.2.1 Containers mounted on, or comprising in whole, or in part, the stress member used in lieu of a frame for cargo vehicles shall comply with DOT cargo tank specifications for LP-Gas service. Such containers shall also comply with Section 2-2, be equipped with appurtenances as provided in Section 2-3 for cargo service, and comply with 6-3.2.1(a):

(a) Liquid hose of 1½ in. (nominal size) and larger size and vapor hose of 1¼ in. (nominal size) and larger size shall be protected with an emergency shutoff valve complying with 2-4.5.4, except that:

(1) If an internal valve meets the provisions of 2-4.5.4 and 3-2.7.9(a)(1), an emergency shutoff valve shall not be required in the cargo container piping.

(2) A back-flow check valve may be used in the cargo container piping or container in lieu of an emergency shutoff valve if the flow is only into the cargo container.

6-3.3 Piping (Including Hose), Fittings and Valves.

6-3.3.1 Pipe, tubing, pipe and tubing fittings, valves, hose and flexible connectors shall comply with Section 2-4, with the provisions of DOT cargo tank specifications for LP-Gas, and shall be suitable for the working pressure specified in 6-3.3.2. In addition, 6-3.3.1(a) through (e) shall apply:

(a) Pipe shall be wrought iron, steel, brass or copper in accordance with 2-4.2.1(a), (b), (c) or (d).

(b) Tubing shall be steel, brass or copper in accordance with 2-4.3.1(a), (b), or (c).

(c) Pipe and tubing fittings shall be steel, brass, copper, malleable iron or ductile (nodular) iron suitable for use with the pipe or tubing used as specified in 6-3.3.1(a) or (b).

(d) Pipe joints may be threaded, flanged, welded or brazed. Fittings when used shall comply with 6-3.3.1(c).

(1) When joints are threaded, or threaded and back welded, pipe and nipples shall be Schedule 80 or heavier. Copper or brass pipe and nipples shall be of equivalent strength.

(2) When joints are welded or brazed, the pipe and nipples shall be Schedule 40 or heavier. Fittings or flanges shall be suitable for the service (*see 6-3.3.2*).

(3) Brazed joints shall be made with a brazing material having a melting point exceeding 1,000 °F (538°C).

(e) Tubing joints shall be brazed, using a brazing material having a melting point of at least 1,000 °F (538°C).

6-3.3.2 Pipe, tubing, pipe and tubing fittings, valves, hose and flexible connectors, and complete cargo vehicle piping systems including connections to equipment (*see 6-3.4*), after assembly, shall comply with 2-5.1.2.

6-3.3.3 Valves, including shutoff valves, excess-flow valves, backflow check valves and remotely controlled valves, used in piping shall comply with the applicable provisions of DOT cargo tank specifications for LP-Gas service, and with 2-4.5, provided, however, that their minimum design pressure shall comply with 6-3.3.2.

6-3.3.4 Hose, hose connections and flexible connectors shall comply with 2-4.6 and 6-3.3.1. Flexible connectors used in the piping system to compensate for stresses and vibration shall be limited to 3 ft (1 m) in overall length. Flexible connectors on existing LP-Gas cargo units replaced after December 1, 1967, shall comply with 2-4.6.

(a) Flexible connectors assembled from rubber hose and couplings installed after December 31, 1974, shall be permanently marked to indicate the date of assembly of the flexible connector and the flexible portion of the connector shall be replaced within six years of the indicated date of assembly of the connector.

(b) The rubber hose portion of flexible connectors shall be replaced whenever a cargo unit is remounted on a different chassis, or whenever the cargo unit is repiped, if such repiping encompasses that portion of piping in which the connector is located, unless the remounting and/or repiping is performed within one year of the date of assembly of the connector.

6-3.3.5 All threaded primary valves and fittings used in liquid filling or vapor equalization directly on the cargo container of transportation equipment shall be of steel, malleable or ductile iron construction. All existing equipment shall be so equipped not later than the scheduled requalification date of the container.

6-3.4 Equipment.

6-3.4.1 LP-Gas equipment, such as pumps, compressors, meters, dispensers, regulators and strainers, shall comply with Section 2-5 as to design and construction and shall be installed in accordance with the applicable provisions of 3-2.10. Equipment on vehicles shall be securely mounted in place and connected into the piping system in accordance with the manufacturer's instructions, taking into account the greater (than for stationary service) jarring and vibration problems incident to vehicular use.

6-3.4.2 Pumps or compressors used for LP-Gas transfer may be mounted on tank trucks, trailers, semitrailers or tractors, and may be driven by the truck or tractor motor power takeoff, by a separate internal combustion engine, or by hand, mechanical, hydraulic or electrical means. If an electric drive is used, obtaining energy from the electrical installation at the delivery point, the installation on the vehicle (and at the delivery point) shall comply with 3-8.2.

6-3.4.3 The installation of compressors shall comply with the applicable provisions of 3-2.10.1 and 6-3.4.1.

6-3.4.4 The installation of liquid meters shall be in accordance with 3-2.10.5(a). If venting of LP-Gas to the air is necessary, provision shall be made to vent it at a safe location.

6-3.4.5 When wet hose is carried connected to the truck liquid pump discharge piping, an automatic device, such as a differential regulator, shall be installed between the pump discharge and the hose connection to prevent liquid discharge when the pump is not operating. When a meter or dispenser is used, this device shall be installed between the meter outlet and the hose connection. An excess-flow valve may also be used but shall not be the exclusive means of complying with this provision.

6-3.5 Protection of Container Appurtenances, Piping System and Equipment.

6-3.5.1 Container appurtenances, piping and equipment comprising the complete LP-Gas system on the cargo vehicle shall be securely mounted in position (*see 6-3.2.1 and 6-3.2.2 for container mounting*), shall be protected against damage to the extent it is practical, and in accordance with DOT regulations.

6-3.6 Painting and Marking Liquid Cargo Vehicles.

6-3.6.1 Painting of cargo vehicles shall comply with CFR 49. Placarding and marking shall comply with CFR 49.

6-3.7 Fire Extinguishers.

6-3.7.1 Each tank truck or tractor shall be provided with at least one approved portable fire extinguisher having a minimum capacity of 20 lb dry chemical with a B:C rating. (*Also see NFPA 10*).

6-3.8 Chock Blocks for Liquid Cargo Vehicles.

6-3.8.1 Each tank truck and trailer shall carry chock blocks which shall be used to prevent rolling of the vehicle whenever it is being loaded or unloaded, or is parked.

6-3.9 Exhaust Systems.

6-3.9.1 The truck engine exhaust system shall comply with Federal Motor Carrier Safety Regulations.

6-3.10 Smoking Prohibition.

6-3.10.1 Truck drivers and their helpers shall not smoke, or allow smoking, around the vehicle on the road, while making liquid transfers, or making repairs to the truck or trailer in accordance with the Federal Motor Carrier Safety Regulations.

6-4 Trailers, Semitrailers, Movable Fuel Storage Tenders or Farm Carts.

6-4.1 Application.

6-4.1.1 This section applies to all cargo vehicles, other than trucks, which may be parked at locations away from distributing points.

6-4.2 Trailers or Semitrailers Comprising Parts of Section 6-3 Vehicles.

6-4.2.1 When parked, cargo tank trailers or semitrailers covered by Section 6-3 shall be positioned so that the pressure relief valves shall communicate with the vapor space of the container.

6-4.3 Trailers, Including Movable Storage Tenders or Farm Carts.

6-4.3.1 Trailers, including fuel storage tenders or farm carts, shall comply with 6-4.3.2 through 6-4.3.6. If normally used over public ways they shall comply with applicable state regulations.

6-4.3.2 Cargo containers mounted on such vehicles shall be constructed in accordance with Section 2-2, and equipped with appurtenances as provided in Section 2-3. Container mounting shall be adequate for the service involved.

6-4.3.3 Threaded piping shall not be less than Schedule 80 and fittings shall be designed for not less than 250 psig (1.7 MPa gauge).

6-4.3.4 Piping, hoses and equipment, including valves, fittings, pressure relief valves and container accessories, shall be adequately protected against collision or upset.

6-4.3.5 Parked vehicles shall be so positioned that container safety relief valves communicate with the vapor space.

6-4.3.6 Such cargo units shall not be filled on a public way.

6-5 Transportation of Stationary Containers to and from Point of Installation.

6-5.1 Application.

6-5.1.1 This section applies to the transportation of containers designed for stationary service at the point of use and secured to the vehicle only for transportation. Such containers may be transported partially filled with LP-Gas.

6-5.2 Transportation of Containers.

6-5.2.1 Except as provided in 6-5.2.1(a), containers of 125 gal (0.5 m^3) or more water capacity shall contain no more than 5 percent of their water capacity in liquid form during transportation.

(a) Containers containing more LP-Gas than 5 percent of their water capacity may be transported subject to such limitations as may be specified by the authority having jurisdiction.

6-5.2.2 Containers shall be safely secured to minimize movement relative to each other or to the carrying vehicle while in transit, giving consideration to the sudden stops, starts and changes of direction normal to vehicular operation.

6-5.2.3 Valves, regulators and other container appurtenances shall be adequately protected against physical damage during transportation.

6-5.2.4 Pressure relief valves shall be in direct communication with the vapor space of the container.

6-5.2.5 Lifting lugs in good repair on containers filled to no more than five percent of their water capacity may be used for lifting and lowering.

(a) Additional means for securing and supporting the container shall be provided for transporting or when lifting or lowering with more than 5 percent of its water capacity [*see 6-5.2.1(a)*].

6-6 Parking and Garaging Vehicles Used to Carry LP-Gas Cargo.

6-6.1 Application.

6-6.1.1 This section applies to the parking (except parking associated with a liquid transfer operation) and garaging of vehicles used for the transportation of LP-Gas. Such vehicles include those used to carry portable containers (*see Section 6-2*) and those used to carry LP-Gas in cargo tanks (cargo vehicles, see Section 6-3).

6-6.2 Parking.

6-6.2.1 Vehicles carrying or containing LP-Gas parked out-of-doors shall comply with the following:

(a) Vehicles, except in an emergency and except as provided in 6-6.2.1(b), shall not be left unattended on any street, highway, avenue or alley, provided that this shall not prevent a driver from the necessary absence from the vehicle in connection with his normal duties, nor shall it prevent stops for meals or rest stops during the day or at night.

(b) Vehicles shall not be parked in congested areas. Such vehicles may be parked off the street in uncongested areas if at least 50 ft (15 m) from any building used for assembly, institutional, or multiple residential occupancy. This shall not prohibit the parking of vehicles carrying portable containers or cargo vehicles of 3500 gal (13 m^3) water capacity or less on streets adjacent to the driver's residence in uncongested residential areas, provided such points of parking are at least 50 ft (15 m) from a building used for assembly, institutional or multiple residential occupancy.

6-6.2.2 Vehicles parked indoors shall comply with the following:

(a) Cargo vehicles parked in any public garage or building shall have LP-Gas liquid removed from the cargo container, piping, pump, meter, hoses and related equipment and the pressure in the delivery hose and related equipment reduced to approximately atmospheric, and all valves closed before being moved inside. Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved inside.

(b) Vehicles used to carry portable containers shall not be moved into any public garage or building for parking until all portable containers have been removed from the vehicle.

(c) Vehicles carrying or containing LP-Gas are permitted to be parked in buildings complying with Chapter 7 and located on premises owned or under the control of the operator of such vehicles, provided:

(1) The public is excluded from such buildings.

(2) There is adequate floor level ventilation in all parts of the building where these vehicles are parked.

(3) Leaks in the vehicle LP-Gas systems are repaired before the vehicle is moved inside.

(4) Primary shutoff valves on cargo tanks and other LP-Gas containers on the vehicle (except propulsion engine fuel containers) are closed and delivery hose outlets plugged or capped to contain system pressure before the vehicle is moved inside. Primary shutoff valves on LP-Gas propulsion engine fuel containers shall be closed when the vehicle is parked.

(5) No LP-Gas container is located near a source of heat or within the direct path of hot air being blown from a blower-type heater.

(6) LP-Gas containers are gauged or weighed to determine that they are not filled beyond the maximum filling density according to 4-5.1.

6-6.2.3 Vehicles are permitted to be serviced or repaired indoors as follows:

(a) When it is necessary to take a vehicle into any building located on premises owned and/or operated by the operator of such vehicle for service on engine or chassis, the provisions of 6-6.2.2(a) or (c) shall be followed.

(b) When it is necessary to take a vehicle carrying or containing LP-Gas into any public garage or repair facility for service on the engine or chassis, the provisions of 6-6.2.2(a) or (b) shall be followed, unless the driver or qualified representative of an LP-Gas operator is in attendance at all times when the vehicle is inside. In that case, the following provisions shall be followed under the supervision of such qualified persons:

(1) Leaks in the vehicle LP-Gas systems shall be repaired before the vehicle is moved inside.

(2) Primary shutoff valves on cargo tanks, portable containers and other LP-Gas containers installed on the vehicle (except propulsion engine fuel containers) are closed. LP-Gas liquid shall be removed from the piping, pump, meter, delivery hose and related equipment and the pressure therein reduced to approximately atmospheric before the vehicle is moved inside. Delivery hose or valve outlets shall be plugged or capped before the vehicle is moved inside.

(3) No container shall be located near a source of heat or within the direct path of hot air blown from a blower or from a blower-type heater.

(4) LP-Gas containers shall be gauged or weighed to determine that they are not filled beyond the maximum filling capacity according to 4-5.1.

(c) If repair work or servicing is to be performed on a cargo tank system, all LP-Gas shall be removed from the cargo tank and piping and the system thoroughly purged before the vehicle is moved inside.

Chapter 7 Buildings or Structures Housing LP-Gas Distribution Facilities

7-1 Scope.

7-1.1 Application.

7-1.1.1 This chapter includes the construction, ventilation and heating of structures housing certain types of LP-Gas systems as referenced in this standard. Such structures may be separate buildings used exclusively for the purpose (or for other purposes having similar hazards), or they may be rooms attached to, or located within, buildings used for other purposes.

7-1.1.2 The provisions of this chapter apply only to buildings constructed or converted after December 31, 1972, except for those previously constructed under the provisions of 5-3.3. Also, see 1-2.4.1.

7-2 Separate Structures or Buildings.

7-2.1 Construction of Structures or Buildings.

7-2.1.1 Separate buildings or structures shall be one story in height and shall have walls, floors, ceilings and roofs constructed of noncombustible materials. Exterior walls, ceilings and roofs shall be constructed as follows:

(a) Of lightweight material designed for explosion venting, or

(b) If of heavy construction, such as solid brick masonry, concrete block or reinforced concrete construction, explosion venting windows or panels in walls or roofs shall be provided having an explosion venting area of at least 1 sq ft (0.1 m^2) for each 50 cu ft (1.4 m^3) of the enclosed volume.

7-2.1.2 The floor of such structures shall not be below ground level. Any space beneath the floor shall preferably be of solid fill. If not so filled, the perimeter of the space shall be left entirely unenclosed.

7-2.2 Structure or Building Ventilation.

7-2.2.1 The structure shall be ventilated utilizing air inlets and outlets arranged to provide air movement across the floor as uniformly as practical and in accordance with 7-2.2.1(a) or (b). The bottom of such openings shall not be more than 6 in. (152 mm) above the floor.

(a) When mechanical ventilation is used, air circulation shall be at least at the rate of one cu ft per minute per sq ft (0.4 $m^3/s/m^2$) of floor area. Outlets shall discharge at least five ft (1.5 m) away from any opening into the structure or any other structure.

(b) When natural ventilation is used, outlet and inlet openings shall be provided, each having a total free area of at least one sq in. (645 mm^2) for each sq ft (0.1 m^2) of floor area.

7-2.3 Structure or Building Heating.

7-2.3.1 Heating shall be by steam or hot water radiation or other heating transfer medium with the heat source located outside of the building or structure (*see Section 3-8, Ignition Source Control*), or by electrical appliances installed in the building, if they are listed for Class I, Group D, Division 2 locations, in accordance with NFPA 70, *National Electrical Code* (*see Table 3-8.2.2*).

7-3 Attached Structures or Rooms Within Structures.

7-3.1 Construction of Attached Structures.

7-3.1.1 Attached structures shall comply with 7-2.1 (attachment shall be limited to 50 percent of the perimeter of the space enclosed; otherwise such space shall be considered as a room within a structure - see 7-3.2), and with the following:

(a) Common walls at points at which structures are to be attached shall:

(1) Have, as erected, a fire resistance rating of at least one hour, as determined by NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

(2) Have no openings. Common walls for attached structures used only for storage of LP-Gas are permitted to have doorways which shall be equipped with 1½ hour (B) fire doors. See NFPA 80, *Fire Doors and Windows*.

(3) Be designed to withstand a static pressure of at least 100 lb (0.7 MPa) per sq ft (0.1 m^2).

(b) The provisions of 7-3.1.1(a) may be waived if the building to which the structure is attached is occupied by operations or processes having a similar hazard.

(c) Ventilation and heating shall comply with 7-2.2.1 and 7-2.3.1.

7-3.2 Construction of Rooms within Structures.

7-3.2.1 Rooms within structures shall be located in the first story and shall have at least one exterior wall with sufficient exposed area to permit explosion venting as provided in 7-3.2.1(a). The building in which the room is located shall not have a basement or unventilated crawl space and the room shall comply with the following:

(a) Walls, floors, ceilings or roofs of such rooms shall be contructed of noncombustible materials. Exterior walls and ceilings shall either be of lightweight material designed for explosion venting, or, if of heavy construction (such as solid brick masonry, concrete block or reinforced concrete construction), shall be provided with explosion venting windows or panels in the walls or roofs having an explosion venting area of at least 1 sq ft (0.1 m^2) for each 50 cu ft (1.4 m^3) of the enclosed volume.

(b) Walls and ceilings common to the room and to the building within which it is located shall:

(1) Have, as erected, a fire-resistance rating of at least one hour as determined by NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*.

(2) Not have openings. Common walls for rooms used only for storage of LP-Gas are permitted to have doorways which shall be equipped with 1½-hour (B) fire doors. See NFPA 80, *Fire Doors and Windows*.

(3) Be designed to withstand a static pressure of at least 100 lb (0.7 MPa) per sq ft (0.1 m^2).

(c) The provisions of 7-3.2.1(b) may be waived if the building within which the room is located is occupied by operations or processes having a similar hazard.

(d) Ventilation and heating shall comply with 7-2.2.1 and 7-2.1.1.

Appendix A Properties of LP-Gases

This Appendix is not a part of the requirements of this NFPA document. . .but is included for information purposes only.

A-1 Approximate Properties of LP-Gases.

A-1.1 Source of Property Values.

A-1.1.1 The property values for the LP-Gases are based on average industry values and include values for LP-Gases coming from natural gas liquids plants as well as those coming from petroleum refineries. Thus, any particular commerical propane or butane might have properties varying slightly from the values shown. Similarly, any propane-butane mixture might have properties varying from those obtained by computation from these average values (*see A-1.2.1 for computation method used*). Since these are average values, the interrelationships between them (i.e., lb per gal, specific gravity, etc.) will not cross-check perfectly in all cases.

A-1.1.2 Such variations are not sufficient to prevent the use of these average values for most engineering and design purposes. They stem from minor variations in composition. The commerical grades are not pure (CP-Chemically Pure) propane or butane, or mixtures of the two, but may also contain small and varying percentages of ethane, ethylene, propylene, iso-butane or butylene which can cause slight variations in property values. There are limits to the accuracy of even the most advanced testing methods used to determine the percentages of these minor components in any LP-Gas.

A-1.2 Approximate Properties of LP-Gases.

A-1.2.1 The principal properties of Commercial Propane and Commercial Butane are shown in Table A-1.2.1. Reasonably accurate property values for propane-butane mixtures may be obtained by computation, applying the percentages by weight of each in the mixture to the values for the property it is desired to obtain. Slightly more accurate results for vapor pressure are obtained by using the percentages by volume. Very accurate results can be obtained using data and methods explained in petroleum and chemical engineering data books.

Table A-1.2.1 (English)) Approximate Properties of LP-Gases

Vapor Pressure in psig at:	**Commercial Propane NLPGA Av.**	**Commercial Butane NLPGA Av.**
70°F	132	17
100°F	205	37
105°F	216	41
130°F	300	69
Specific Gravity of Liquid at 60°F	0.509	0.582
Initial Boiling Point at 14.7 psia, Degrees F	-51	15
Weight per Gallon of Liquid at 60°F, lb.	4.24	4.81
Specific Heat of Liquid, Btu/lb. at 60°F	0.588	0.549
Cu. ft of Vapor per Gallon at 60°F	36.39	31.26
Cu. ft of Vapor per Pound at 60°F	8.58	6.51
Specific Gravity of Vapor (Air = 1) at 60°F	1.52	2.01
Ignition Temperature in Air, Degrees°F	920-1120	900-1000
Maximum Flame Temperature in Air, Degrees°F	3,595	3,615
Limits of Flammability in Air, Percent of Vapor in Air-Gas Mixture:		
(a) Lower	2.15	1.55
(b) Upper	9.60	8.60
Latent Heat of Vaporization at Boiling Point:		
(a) Btu per Pound	185	167
(b) Btu per Gallon	785	808
Total Heating Values after Vaporization:		
(a) Btu per Cubic Foot	2,516	3,280
(b) Btu per Pound	21,591	21,221
(c) Btu per Gallon	91,547	102,032

Table A-1.2.1 (Metric) Approximate Properties of LP-Gases

Vapor Pressure in kPa gage at:	Commercial Propane	Commercial Butane
20°C	930	103
40°C	1 550	285
45°C	1 720	345
55°C	2 070	462
Specific Gravity	0.509	0.582
Initial Boiling Point at atm, pressure, °C	-46	-9
Weight per cubic meter of liquid at 15.56°C, kg	509	582
Specific Heat of Liquid, kilojoule per kilogram, at 15.56°C	1.366	1.276
Cubic metre of Vapor per litre of liquid at 15.56°C	0.271	0.235
Cubic metre of Vapor per kilogram of liquid at 15.56°C	0.534	0.410
Specific Gravity of Vapor (Air=1) at 15.56°C	1.52	2.01
Ignition Temperature in Air, °C	493-549	482-538
Maximum Flame Temperature in Air, °C	1 980	2 008
Limits of Flammability in Air, % of Vapor in Air-Gas Mixture:		
(a) Lower	2.15	1.55
(b) Upper	9.60	9.60
Latent Heat of Vaporization at Boiling Point:		
(a) Kilojoule per kilogram	430	388
(b) Kilojoule per litre	219	226
Total Heating Value after Vaporization:		
(a) Kilojoule per cubic metre	93 470	121 280
(b) Kilojoule per kilogram	50 020	49 140
(c) Kilojoule per litre	25 430	28 100

Appendix B Design, Construction and Requalification of DOT (ICC) Cylinder Specification Containers

This Appendix is not a part of the requirements of this NFPA document. . .but is included for information purposes only.

B-1 Scope.

B-1.1 Application.

B-1.1.1 This appendix provides general information on DOT cylinder specification containers referred to in this standard. For complete information consult the applicable specification (*see B-2.1.1*). The water capacity of such cylinders may not be more than 1,000 lb (454 kg).

B-1.1.2 This appendix is not applicable to DOT tank car portable tank container or cargo tank specifications. Portable and cargo tanks are basically ASME containers and are covered in Appendix C.

B-1.1.3 Prior to April 1, 1967, these specifications were promulgated by the Interstate Commerce Commission (ICC). On this date, certain functions of the ICC, including the promulgation of specifications and regulations dealing with LP-Gas cylinders, were transferred to the Department of Transportation (DOT). Throughout this appendix both ICC and DOT are used; ICC applying to dates prior to April 1, 1967, and DOT to subsequent dates.

B-2 LP-Gas Cylinder Specifications.

B-2.1 Publishing of DOT Cylinder Specifications.

B-2.1.1 DOT Cylinder specifications are published under Title 49, *Code of Federal Regulations*, Parts 171-190, available from US Government Printing Office, Washington, D.C. The information in this publication is also issued as a Tariff at approximately three year intervals by the Bureau of Explosives, American Railroads Building, 1920 L Street, NW, Washington, DC 20036.

B-2.2 DOT Specification Nomenclature.

B-2.2.1 The specificaion designation consists of a one-digit number, sometimes followed by one or more capital letters, then by a dash and a three-digit number. The one-digit number alone, or in combination with one or more capital letters, designates the specification number. The three-digit number following the dash shows the service pressure for which the container is designed. Thus, "4B-240" indicates a cylinder built to Specification 4B for a 240 psig service pressure. (*See B-2.2.3.*)

B-2.2.2 The specification gives the details of cylinder construction, such as material used, method of fabrication, tests required and inspection method, and prescribes the service pressure, or range of service pressures for which that specification may be used.

B-2.2.3 The term "service pressure" is analagous to, and serves the same purpose as, the ASME "design pressure." However, it is not identical, representing instead the highest pressure to which the container will normally be subjected in transit or in use but not necessarily the maximum pressure to which it may be subjected under emergency conditions in transportation. The service pressure stipulated for the LP-Gases is based on the vapor pressures exerted by the product in the container at two different temperatures, the higher pressure of the two becoming the service pressure, as follows:

(a) The pressure in the container at 70°F must be less than the service pressure for which the container is marked, and

(b) The pressure in the container at 130°F must not exceed 5/4 times the pressure for which the container is marked.

EXAMPLE: Commercial Propane has a vapor pressure at 70°F of 132 psig. However, its vapor pressure at 130°F is 300 psig, so service pressure (5/4 times which must not exceed 300 psig) is 300 divided by 5/4, or 240 psig. Thus commercial propane requires at least 240 psig service pressure cylinder.

B-2.3 Dot Cylinder Specifications Used for LP-Gas.

B-2.3.1 A number of different specifications were approved by ICC, and since 1967 by DOT, for use with LP-Gases. Some of these are no longer published or used for new construction. However, containers built under these old specifications, if properly maintained and requalified, are still acceptable for LP-Gas transportation.

B-2.3.2 DOT specifications cover primarily safety in transportation. However, in order for the product to be used, it is necessary for it to come to rest at the point of use and serve as LP-Gas storage during the period of use. Containers adequate for transportation are also deemed to be adequate for use as provided in NFPA 58. As small size ASME containers were not available at the time tank truck delivery was started, ICC (now DOT) cylinders have been equipped for tank truck deliveries and permanently installed.

B-2.3.3 The DOT cylinder specifications most widely used for the LP-Gases are shown in Table B-2.3.3. The differing materials of construction, method of fabrication and the date of the specification reflect the progress made in knowledge of the products to be contained and improvement in metallurgy and methods of fabrication.

Table B-2.3.3

Specification No. & Marking	Material of Construction	Method of Fabrication
26–150*	Steel	Welded and Brazed
3B–300	Steel	Seamless
4–300	Steel	Welded
4B–300	Steel	2 piece Welded & Brazed
4B-240	Steel	2 piece Welded & Brazed
4BA-240	Alloy Steel	2 piece Welded & Brazed
4E-240	Aluminum	Welded and Brazed
4BW-240	Steel	3 piece Welded

*The term "service pressure" had a different connotation at the time the specification was adopted.

B-3 Requalification, Retesting and Repair of DOT Cylinder Specification Containers.

B-3.1 Application.

B-3.1.1 This section outlines the requalification, retesting and repair requirements for DOT cylinder specification containers *but should be used only as a guide*. For official information, the applicable DOT regulations should be consulted.

B-3.2 Requalification (Including Retesting) of DOT Cylinders.

B-3.2.1 DOT cylinders may not be refilled, continued in service or transported unless they are properly qualified or requalified for LP-Gas service in accordance with DOT regulations.

B-3.2.2 A careful examination must be made of every container each time it is to be filled and it must be rejected if there is evidence of exposure to fire, bad gouges or dents, seriously corroded areas, leaks, or other conditions indicating possible weaknesses which might render it unfit for service. The following disposition is to be made of rejected cylinders:

(a) Containers subjected to fire must be requalified, reconditioned or repaired in accordance with B-3.3.1, or permanently removed from service except that DOT 4E (aluminum) cylinders must be permanently removed from service.

(b) Containers showing serious physical damage, leaks or with a reduction in the marked tare weight of 5 percent or more must be retested in accordance with B-3.2.4(a) or (b) and, if necessary, repaired in accordance with B-3.3.1.

B-3-2.3 All containers, including those apparently undamaged, must be periodically requalified for continued service. The first requalification for a new cylinder is required within 12 years after the date of manufacture. Subsequent requalifications are required within the periods specified under the requalification method used.

B-3.2.4 DOT regulations permit three alternative methods of requalification for most commonly used LP-Gas specification containers (*see DOT regulations for permissible requalification methods for specific cylinder specifications*). Two use hydrostatic testing, and the third uses a carefully made and duly recorded visual examination by a competent person. In the case of the two hydrostatic test methods, only test results are recorded but a careful visual examination of each container is also required. DOT regulations cite in detail the data to be recorded for the hydrostatic test methods, the observations to be made during the recorded visual examination method, and the marking of containers to indicate the requalification date and the method used. The three methods are outlined as follows:

(a) The water jacket type hydrostatic test may be used to requalify containers for 12 years before the next requalification is due. A pressure of twice the marked service pressure is applied, using a water jacket (or the equivalent) so that the total expansion of the container during the application of the test pressure can be observed and recorded for comparison with the permanent expansion of the container after depressurization. The following disposition is made of containers tested in this manner:

(1) Containers which pass the retest, and the visual examination required with it (*see B-3.2.4*), are marked with the date and year of the test (Example "6-70," indicating requalification by the water jacket test method in June 1970) and may be placed back in service.

(2) Containers which leak, or for which the permanent expansion exceeds 10 percent of the total expansion (12 percent for Specification 4E aluminum cylinders) must be rejected. If rejected for leakage, containers may be repaired in accordance with B-3.3.1.

(b) The simple hydrostatic test may be used to requalify containers for 7 years before the next requalification is due. A pressure of twice the marked service pressure is applied but no provision is made for measuring total and permanent expansion during the test outlined in B-3.2.4(a) above. The container is carefully observed while under the test pressure for leaks, undue swelling or bulging indicating weaknesses. The following disposition is made of containers tested in this matter:

(1) Containers which pass the test, and the visual examination required with it (*see B-3-2.4*), are marked with the date and year of the retest followed by an "S" (Example: "8-71S," indicating requalification by the simple hydrostatic test method in August 1971), and may be placed back in service.

(2) Containers developing leaks or showing undue swelling or bulging must be rejected. If rejected for leaks, containers may be repaied in accordance with B-3.3.1.

(c) The recorded visual examination may be used to requalify containers for 5 years before the next qualification is due provided the container has been used exclusively for LP-Gas commerically free from corroding components. Inspection is to be made by a competent person, using as a guide Compressed Gas Association "Standards for the Visual Inspection of Compressed Gas Cylinders" (CGA Pamphlet C-6), and recording the inspection results as required by DOT regulations. [Note: Reference to NLPGA Safety Bulletin, Recommended Procedures for Visual Inspection and Requalification of DOT (ICC) Cylinders in LP-Gas Service, is also recommended.] The following disposition is to be made of containers inspected in this manner:

(1) Containers which pass the visual examination are marked with the date and year of the examination followed by an "E" (Example: "7-70E," indicating requalification by the recorded visual examination method in July 1970), and may be placed back in service.

(2) Containers which leak, show serious denting or gouging, or excessive corrosion must either be scrapped or repaired in accordance with B-220.

B-3.3 Repair of DOT Cylinder Specification Containers.

B-3.3.1 Repair of DOT cylinders must be performed by a manufacturer of the type of cylinder to be repaired or by a repair facility authorized by DOT.

Repairs normally made are for fire damage, leaks, denting, gouges and for broken or detached valve protecting collars or foot rings.

Appendix C Design of ASME and API-ASME Containers

This Appendix is not a part of the requirements of this NFPA document. . .but is included for information purposes only.

C-1 General.

C-1.1 Application.

C-1.1.1 This appendix provides general information on containers designed and constructed in accordance with ASME or API-ASME Codes, usually referred to as ASME containers. For complete information on either ASME or API-ASME containers the applicable code should be consulted. Construction of containers to the API-ASME Code has not been authorized since July 1, 1961.

C-1.1.2 DOT (ICC) specification portable tank containers and cargo tanks are basically either ASME or API-ASME containers. In writing these specifications, which should be consulted for complete information, additions were made to these pressure vessel codes to cover the following:

(a) Protection of container valves and appurtenances against physical damage in transportation.

(b) Holddown devices for securing cargo containers to conventional vehicles.

(c) Attachments to relatively large [6,000 gal (22.7 m^3) or more water capacity] cargo containers in which the container serves as a stress member in lieu of a frame.

C-1.2 Development of ASME and API-ASME Codes.

C-1.2.1 ASME type containers of approximately 12,000 gal (45.4 m^3) water capacity or more were initially used for bulk storage in processing, distribution and industrial plants. As the industry expanded and residential and commercial usage increased, the need for small ASME containers with capacities greater than the upper limit for DOT cylinders grew. This ulitmately resulted in the development of cargo containers for tank trucks and the wide use of ASME containers ranging in size from less than 25 gal (0.1 m^3) to 120,000 gal (454 m^3) water capacity.

C-1.2.2 The American Society of Mechanical Engineers (ASME) in 1911 set up the Boiler and Pressure Vessel Committee to formulate "standard rules for the construction of steam boilers and other pressure vessels." The ASME Boiler and Pressure Vessel Code, first published in 1925, has been revised and republished in 22 separate editions including the 1980 edition. During this period there have been changes in the code as materials of construction improved and more was known about them, and as fabrication methods changed and inspection procedures were refined.

C-1.2.3 One major change involved the so-called "factor of safety" (the ratio of the ultimate strength of the metal to the design stress used). Prior to 1946, a 5:1 safety factor was used. Fabrication changed from the riveting widely used when the code was first written (some forge welding was used), to fusion welding. This latter method was incorporated into the code as welding techniques were perfected, and now predominates.

C-1.2.4 The safety factor change in the ASME Code was based on the technical progress made since 1925 and on experience with the use of the API-ASME Code. This offshoot of the ASME Code, initiated in 1931, was formulated and published by the American Petroleum Institute (API) in cooperation with the ASME. It justified the 4:1 safety factor on the basis of certain quality and inspection controls not at that time incorporated in the ASME Code editions.

C-1.2.5 ASME Code case interpretations and addenda are published between Code editions and normally become part of the Code in the new edition. Adherence to these is considered compliance with the Code. [*See 2-2.1.3(a).*]

C-2 Design of Containers for LP-Gas.

C-2.1 ASME Container Design.

C-2.1.1 When ASME containers were first used to store LP-Gas, the properties of the CP grades of the principal constituents were available, but the average properties for the commercial grades of propane and butane were not. Also there was no experience as to what temperatures and pressures to expect for product stored in areas with high atmospheric temperatures. A 200 psi (1.4 MPa) design pressure was deemed appropriate for propane (the CP grade of which has a vapor pressure of 176 psi (1.2 MPa) at 100°F (37.8°C) and 80 psi (0.6 MPa) for butane (CP grade has vapor pressure of 37 psi (0.6 MPa) at 100°F (37.8°C). These containers were built with a 5:1 safety factor (*see C-1.2.3*).

C-2.1.2 Pressure vessel codes, following boiler pressure relief valve practice, require that the pressure relief valve start-to-leak setting be the design pressure of the container. In specifying pressure relief valve capacity, however, they stipulate that this relieving capacity be adequate to prevent the internal pressure from rising above 120 percent of the design pressure under fire exposure conditions.

C-2.1.3 Containers built in accordance with C-2.1.1 were entirely adequate for the commercial grades of the LP-Gases (the vapor pressure of propane at 100°F (37.8°C) is 205 psi (1.43 MPa); the vapor pressure of butane at 100°F (37.8°C) is 37 psi (0.26 MPa)). However, as they were equipped with pressure relief valves set to start-to-leak at the design pressure of the container, these relief valves occasionally opened on an unusually warm day. Since any unnecessary release of a flammable gas is potentially dangerous, and giving weight to recommendations of fire prevention and insurance groups as well as to the favorable experience with API-ASME containers (*see C-2.2.1*), relief valve settings above the design pressure [up to 250 psi (1.7 MPa) for propane and 100 psi (0.7 MPa) for butane] were widely used.

C-2.1.4 In determining safe filling densities for compressed liquefied gases, DOT (ICC) uses the criterion that the container shall not become liquid full at the highest temperature the liquid may be expected to reach due to the normal atmospheric conditions to which the container may be exposed. For containers of more than 1,200 gal (4.5 m^3) water capacity, the liquid temperature selected is 115°F (46°C). The vapor pressure of the gas to be contained at 115°F (46°C) is specified by DOT as the minimum design pressure for the container. The vapor pressure of CP propane at 115°F (46°C) is 211 psig (1.4 MPa gauge), and of commercial propane, 243 psig (1.5 MPa gauge). The vapor pressure of both normal butane and commercial butane at 115°F (46°C) is 51 psig (0.4 MPa gauge).

C-2.1.5 The ASME Pressure Vessel Code editions generally applicable to LP-Gas containers, and the design pressures, safety factors and exceptions to these editions for LP-Gas use, are shown in Table C-2.1.5. These reflect the use of the information in C-2.1.1 through C-2.1.4.

Table C-2.1.5

Year ASME Code Edition Published	Design Pressure, psi (Pascals) Butane	Propane	Safety Factor
1931 through 46[2]	100[1] (0.7)	200 (1.4)	5:1
1949 Par. U-68 & U-69[2]	100 (0.7)	200 (1.4)	5:1
1949 Par. U-200 & U-201[2]	125 (0.9)	250 (1.7)	4:1
1952 through 80	125 (0.9)	250[3] (1.7)	4:1

[1] Until December 31, 1947, containers designed for 80 psi (0.6 MPa) under prior (5:1 safety factor) codes were authorized for butane. Since that time, either 100 psi (0.7 MPa) (under prior codes) or 125 psi (0.9 MPa) (under present codes) is required.

[2] Containers constructed in accordance with 1949 and prior editions of the ASME Code were not required to be in compliance with paragraphs U-2 to U-10 inclusive, or with paragraph U-19. Construction in accordance with paragraph U-70 of these editions was not authorized.

[3] Higher design pressure [312.5 psi (2.2 MPa)] is required for small ASME containers used for vehicular installations (such as forklift trucks used in buildings or those installed in enclosed spaces) because they may be exposed to higher temperatures and consequently develop higher internal pressure.

C-2.2 API-ASME Container Design.

C-2.2.1 The API-ASME Code was first published in 1931 (*see C-2.1.4*). Based on petroleum industry experience using certain material quality and inspection controls not at that time incorporated in the ASME Code, the 4:1 safety factor was first used. Many LP-Gas containers were built under this code with design pressures of 125 psi (0.9 MPa) [100 psi (0.7 MPa) until December 31, 1947] for butane and 250 psi (1.7 MPa) for propane. Containers constructed in accordance with the API-ASME Code were not required to comply with Section 1, or the appendix to Section 1. Paragraphs W-601 through W-606 of the 1943 and earlier editions were not applicable to LP-Gas containers.

C-2.2.2 The ASME Code, by changing from the 5:1 to the 4:1 safety factor through consideration of the factors described in C-2.1.1 through C-2.1.4, became nearly identical in effect to the API-ASME Code by the 1950's. Thus, the API-ASME Code was phased out and construction was not authorized after July 1, 1961.

C-2.3 Design Criteria for LP-Gas Containers.

C-2.3.1 To prevent confusion in earlier editions of NFPA 58, the nomenclature "container type" was used to designate the design pressure of the container to be used for various types of LP-Gases. With the adoption of the 4:1 safety factor in the ASME Code and the phasing out of the API-ASME Code, the need for "container type" ceased to exist. Table C-2.3.1 makes it possible to compare older containers which may have carried this designation with the new containers complying with 2-2.2.2 and Table 2-2.2.2 in this standard.

Table C-2.3.1 Vapor Pressure, Design Pressures and Container Type

As Shown in Table 2-2.2.2		Design Press. Earlier Codes		
Maximum Vapor Press. at 100°F (37.8°C)	Design Press. Present ASME Code[1]	API-ASME	ASME[2]	Container Type
80 (.6)	100 (.7)	100 (.7)	80 (.6)	80 (.6)
100 (.7)	125 (.9)	125 (.9)	100 (.7)	100 (.7)
125 (.9)	156 (1.1)	156 (1.1)	125 (.9)	125 (.9)
150 (1.0)	187 (1.3)	187 (1.3)	150 (1.0)	150 (1.0)
175 (1.2)	219 (1.5)	219 (1.5)	175 (1.2)	175 (1.2)
215 (1.5)	250 (1.7)	250 (1.7)	200 (1.4)	200 (1.4)
215 (1.5)	312.5 (2.2)	312.5 (2.2)	—	250 (1.7)

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[1] ASME Code edition for 1949, Par. U-200 and U-201 and all later editions (*See C-2.1.5*).

[2] All ASME Codes up to the 1946 edition and paragraphs U-68 and U-69 of the 1949 edition (*See C-2.1.5*).

C-2.4 DOT (ICC) Specifications Utilizing ASME or API-ASME Containers.

C-2.4.1 DOT (ICC) Specifications for portable tank containers and cargo tanks require ASME or API-ASME construction for the container proper (*see C-1.1.2*). Several such specifications were written by the ICC prior to 1967 and DOT has continued this practice.

C-2.4.2 ICC Specifications written prior to 1946, and to some extent through 1952, used ASME containers with a 200 psig (1.4 MPa gauge) design pressure for propane and 80 psig (.6 MPa gauge) for butane [100 psig (.7 MPa guage) after 1947] with a 5:1 the safety factor. During this period and until 1961, ICC Specifications also permitted API-ASME containers with a 250 psig (1.7 MPa gauge) design pressure for propane and 100 psig (.7 MPa gauge) for butane [125 psig (.9 MPa gauge) after 1947].

C-2.4.3 To prevent any unnecessary release of flammable vapor during transportation (*see C-2.1.3*), the use of safety relief valve settings 25 percent above the design pressure was common for ASME 5:1 safety factor containers. To eliminate confusion, and in line with the good experience with API-ASME containers, the ICC permitted the rerating of these particular ASME containers used under its specifications to 125 percent of the originally marked design pressure.

C-2.4.4 DOT (ICC) Specifications applicable to portable tank containers and cargo tanks currently in use are listed in Table C-2.4.4. New construction is not permitted under the older specifications. However, these older containers may continue to be used provided they have been maintained in accordance with DOT (ICC) Regulations.

Table C-2.4.4

Spec. Number	ASME Construction			API-ASME Construction		
	Design Pressure, psig		Safety Factor	Design Pressure, psig		Safety Factor
	Propane	Butane		Propane	Butane	
ICC-50[1]	200[3]	100[3]	5:1	250	125	4:1
ICC-51[1]	250	125	4:1	250	125	4:1
MC-320[2, 4]	200[3]	100[3]	5:1	250	125	4:1
MC-330[2]	250	125	4:1	250	125	4:1
MC-331[2]	250	125	4:1	250	125	4:1

[1] Portable Tank Container.

[2] Cargo Tank

[3] Permitted to be rerated to 125 percent of original ASME Design Pressure.

[4] Require DOT Exemption.

For SI Units
100 psig = .7 MPa gauge; 125 psig = .9 MPa gauge;
200 psig = 1.4 MPa gauge; 250 psig = 1.7 MPa gauge

C-3 Underground ASME or API-ASME Containers.

C-3.1 Use of Containers Underground.

C-3.1.1 ASME or API-ASME containers are used for underground or partially underground installation in accordance with 3-2.3.8 or 3-2.3.9. The temperature of the soil is normally low so that the average liquid temperature and vapor pressure of product stored in underground containers will be lower than in aboveground containers. This lower operating pressure provides a substantial corrosion allowance for underground containers.

C-3.1.2 Containers listed to be used interchangeably for either installation aboveground or underground must comply as to pressure relief valve rated relieving capacity and filling density with aboveground provisions when installed aboveground [*see 2-3.2.4(a)*]. When installed underground the pressure relief valve rated relieving capacity and filling density may be in accordance with underground provisions (*see D-2.3.1*), provided all other underground installation provisions are met. Partially underground containers are considered as aboveground insofar as loading density and pressure relief valve rated relieving capacity are concerned.

Appendix D Pressure Relief Devices

(This Appendix contains mandatory provisions.)

D-1 Pressure Relief Devices for DOT (ICC) Cylinders.

D-1.1 Source of Provisions for Relief Devices.

D-1.1.1 The requirements for relief devices on DOT cylinders are established by the Bureau of Explosives with DOT approval. Complete technical information as to these requirements will be found in the Compressed Gas Association (CGA) Pamphlet S-1.1, Pressure Relief Device Standards, Part 1 - Cylinders for Compressed Gases.

D-1.2 Essential Requirements of LP-Gas Cylinder Relief Devices.

D-1.2.1 CGA Pamphlet S-1.1 provides that LP-Gas cylinders shall be equipped with fusible plugs, spring-loaded pressure relief valves, or a combination of the two. Fusible plugs are not permitted on cylinders used in certain vehicular installations [*see 3-6.2.3(a)(4)*]. The provisions of D-1.2.2 through D-1.2.4 outline the generally accepted industry practice in the use of fusible plugs and pressure relief devices on LP-Gas cylinders.

D-1.2.2 If fusible plugs constitute the only relief devices the plugs used shall comply with the flow capacity requirements of CGA S-1.1 with a nominal melting or yield point of 165°F (74°C) [not less than 157°F (69.5°C) nor more than 170°F (77°C)]. For cylinders over 30 in. (774 mm) long (exclusive of neck), a plug is required in each end of the cylinder.

D-1.2.3 If a spring-loaded pressure relief valve(s) constitutes the only relief device, the valves used shall comply with the flow capacity requirements of CGA S-1.1, with the set pressure not less than 75 percent nor more than 100 percent of the minimum required test pressure of the cylinder. For example, the test pressure for a 240 psig (1.6 MPa gauge) service pressure is 480 psig (3.2 MPa gauge); 75 percent of this is 360 psig (2.5 MPa gauge). In practice, such valves are set at 375 psig (2.6 MPa gauge).

D-1.2.4 If fusible plugs and spring-loaded pressure relief valves are used in combination, this combined use shall be in accordance with CGA S-1.1, or in substance as follows:

(a) If 100 percent of the relief device capacity is provided by the pressure relief valve, the supplementary fuse plug may be of any convenient size provided the total plug area does not exceed 0.25 sq in. (1.6 cm²), and may have a melting point of more than 170°F (77°C) [usually a nominal yield point of 212°F (100°C), with the upper limit not to exceed 220°F (104°C)]. Combination devices are required at one end of a cylinder only, or may be separated and installed at opposite ends.

(b) If at least 70 percent of the relief device capacity is provided by the pressure relief valve, the balance of the capacity requirement shall be supplied by a 165°F (74°C) nominal yield point fusible plug in accordance with D-1.2.2. Combined devices are required at one end of a cylinder only or may be separated and installed at opposite ends.

D-2 Pressure Relief Devices for ASME Containers.

D-2.1 Source of Provisions for Relief Devices.

D-2.1.1 Capacity requirements for relief devices are in accordance with the applicable provisions of Compressed Gas Association (CGA) Pamphlet S-1.2, Pressure Relief Device Standards, Part 2 - Cargo and Portable Tanks for Compressed Gases; or with CGA Pamphlet S-1.3, Safety Relief Device Standards, Part 3 - Compressed Gas Storage Containers.

D-2.2 Spring-Loaded Pressure Relief Valves for Aboveground and Cargo Containers.

D-2.2.1 The minimum rate of discharge for spring-loaded pressure relief valves is based on the outside surface of the containers on which the valves are installed. Paragraph 2-2.6.5(g) provides that new containers shall be marked with the surface area in sq ft. The surface area of containers not so marked (or not legibly marked) may be computed by use of the applicable formula:

(a) Cylindrical container with hemispherical heads:

Surface area = overall length × outside diameter × 3.1416.

(b) Cylindrical container with other than hemispherical heads:

Surface area = (overall length + 0.3 outside diameter) × outside diameter × 3.1416.

NOTE: This formula is not precise, but will give results with limits of practical accuracy in sizing relief valves.

(c) Spherical containers:

Surface area = outside diameter squared × 3.1416.

D-2.2.2 The minimum required relieving capacity in cu ft per minute of air at 120 percent of the maximum permitted start-to-leak pressure (or Flow Rate CFM Air), under standard conditions of 60°F (15.6°C) and atmospheric pressure [14.7 psia (0.1 MPa absolute)], shall be as shown in Table D-2.2.2 for the surface area in sq ft of the container on which the pressure relief valve is to be installed. The flow rate may be interpolated for intermediate values of surface area. For containers with a total outside surface area exceeding 2,000 sq ft, the required flow rate shall be calculated, using the formula: Flow Rate CFM Air = $53.632 \times A^{0.82}$ where A = total outside surface area of container in sq ft.

D-2.3 Spring-Loaded Pressure Relief Valves for Underground or Mounded Containers.

D-2-3.1 In the case of containers installed underground or mounded, the pressure relief valve relieving capacities may be as small as 30 percent of those specified in Table D-2.2.2 provided the container is empty of liquid when installed, that no liquid is placed in it until it is completely covered with earth, and that it is not uncovered for removal until all liquid has been removed.

D-2.3.2 Containers partially underground must have pressure relief valve relieving capacitites in accordance with 2-3.2.4.

D-2.4 Provisions for Fusible Plugs.

D-2.4.1 Fuse plugs, supplementing spring-loaded pressure relief valves, and complying with 2-3.2.4(e), are permitted only with aboveground stationary containers of 1,200 gal (4.5 m^3) or less water capacity. They shall not be used on larger containers nor on portable or cargo containers of ASME construction. The total fusible plug discharge area is limited to 0.25 sq in. (1.6 cm^2) per container.

D-2.5 Pressure Relief Valve Testing.

D-2.5.1 Frequent testing of pressure relief valves on LP-Gas containers is not considered necessary for the following reasons:

(a) The LP-Gases are so-called "sweet gases" having no corrosive or other deleterious effect on the metal of the containers or relief valves.

(b) The relief valves are constructed of corrosion-resistant materials, and are installed so as to be protected against the weather. The variations of temperature and pressure due to atmospheric conditions are not sufficient to cause any permanent set in the valve springs.

(c) The required odorization of the LP-Gases makes escape almost instantly evident.

Table D-2.2.2

Surface Area Sq. Ft.	Flow Rate CFM Air	Surface Area Sq. Ft.	Flow Rate CFM Air	Surface Area Sq. Ft.	Flow Rate CFM Air
20 or less	626	170	3620	600	10170
25	751	175	3700	650	10860
30	872	180	3790	700	11550
35	990	185	3880	750	12220
40	1100	190	3960	800	12880
45	1220	195	4050	850	13540
50	1330	200	4130	900	14190
55	1430	210	4300	950	14830
60	1540	220	4470	1000	15470
65	1640	230	4630	1050	16100
70	1750	240	4800	1100	16720
75	1850	250	4960	1150	17350
80	1950	260	5130	1200	17960
85	2050	270	5290	1250	18570
90	2150	280	5450	1300	19180
95	2240	290	5610	1350	19780
100	2340	300	5760	1400	20380
105	2440	310	5920	1450	20980
110	2530	320	6080	1500	21570
115	2630	330	6230	1550	22160
120	2720	340	6390	1600	22740
125	2810	350	6540	1650	23320
130	2900	360	6690	1700	23900
135	2990	370	6840	1750	24470
140	3080	380	7000	1800	25050
145	3170	390	7150	1850	25620
150	3260	400	7300	1900	26180
155	3350	450	8040	1950	26750
160	3440	500	8760	2000	27310
165	3530	550	9470		

(d) Experience over the years with the storage of LP-Gases has shown a good safety record on the functioning of pressure relief valves.

D-2.5.2 Since no mechanical device can be expected to remain in operative condition indefinitely, it is suggested that the pressure relief valves on containers of more than 2,000 gal (7.6 m^3) water capacity be tested at approximately 10-year intervals. Some types of valves may be tested by the use of an external lifting device having an indicator to show the pressure equivalent at which the valve may be expected to open. Others must be removed from the container for testing, requiring that the container first be emptied.

Appendix E Liquid Volume Tables, Computations and Graphs

This Appendix is not a part of the requirements of this NFPA document. . .but is included for information purposes only.

E-1 Scope.

E-1.1 Application.

E-1.1.1 This appendix explains the basis for Table 4-5.2.1, includes the LP-Gas liquid volume temperature correction table, Table E-3.1.3, and describes its use. It also explains the methods of making liquid volume computations to determine the maximum permissible LP-Gas content of containers in accordance with Tables 4-5.2.3(a), (b) and (c).

E-2 Basis for Determination of LP-Gas Container Capacity.

E-2.1 The basis for determination of the maximum permitted filling densities shown in Table 4-5.2.1 is the maximum safe quantity which will assure that the container will not become liquid full when the liquid is at the highest anticipated temperature.

(a) For portable containers built to DOT specifications and other aboveground containers with water capacities of 1,200 gal or less, this temperature is assumed to be 130°F.

(b) For other aboveground uninsulated containers with water capacities in excess of 1,200 gal, including those built to DOT portable or cargo tank specifications, this temperature is assumed to be 115°F.

(c) For all containers installed underground, this temperature is assumed to be 105°F.

E-3 Liquid Volume Correction Table.

E-3.1 Correction of Observed Volume to Standard Temperature Condition (60°F and equilibrium pressure).

E-3.1.1 The volume of a given quantity of LP-Gas liquid in a container is directly related to its temperature, expanding as temperature increases and contracting as temperature decreases. Standard conditions, often used for weights and measures purposes and, in some cases, to comply with safety regulations, specify correction of the observed volume to what it would be at 60°F.

E-3.1.2 To correct the observed volume to 60°F, the specific gravity of LP-Gas at 60°F in relation to water at 60°F (usually referred to as "60°F/60°F"), and its average temperature must be known. The specific gravity normally appears on the shipping papers. The average liquid temperature may be obtained as follows:

(a) Insert a thermometer in a thermometer well in the container into which the liquid has been transferred and read the temperature after the completion of the transfer [*see E-3.1.2(c) as to proper use of a thermometer*].

(b) If the container is not equipped with a well, but is essentially empty of liquid prior to loading, the temperature of the liquid in the container from which liquid is being withdrawn may be used. Otherwise, a thermometer may be inserted in a thermometer well or other temperature sensing device installed in the loading line at a point close to the container being loaded, reading temperatures at intervals during transfer and averaging. [*See E-3.1.2(c)*].

(c) A suitable liquid should be used in thermometer wells to obtain an efficient heat transfer from the LP-Gas liquid in the container to the thermometer bulb. The liquid used should be noncorrosive and should not freeze at the temperatures to which it will be subjected. Water should not be used.

E-3.1.3 The volume observed or measured is corrected to 60°F by use of Table E-3.1.3. The column headings, across the top of the tabulation, list the range of specific gravities for the LP-Gases complying with 1-2.1.1. Specific gravities are shown from 0.500 to 0.590 by 0.010 increments, except that special columns are inserted for chemically pure propane, iso-butane and normal butane. To obtain a correction factor, follow down the column for the specific gravity of the particular LP-Gas to the factor corresponding with the liquid temperature. Interpolation between the specific gravities and temperatures shown may be used if necessary.

E-3.2 Use of Liquid Volume Correction Factors, Table E-3.1.3.

E-3.2.1 To correct the observed volume in gal for any LP-Gas (the specific gravity and temperature of which is known) to gal at 60°F, Table E-3.1.3 is used as follows:

(a) Obtain the correction factor for the specific gravity and temperature as described in E-3.1.3.

(b) *Multiply* the gal observed by this correction factor to obtain the gal at 60°F.

Table E-3.1.3

Liquid Volume Correction Factors

Observed Temperature Degrees Fahrenheit	SPECIFIC GRAVITIES AT 60° F./60° F.												
	0.500	Propane 0.5079	0.510	0.520	0.530	0.540	0.550	0.560	iso-Butane 0.5631	0.570	0.580	n-Butane 0.5844	0.590
	VOLUME CORRECTION FACTORS												
–50	1.160	1.155	1.153	1.146	1.140	1.133	1.127	1.122	1.120	1.116	1.111	1.108	1.106
–45	1.153	1.148	1.146	1.140	1.134	1.128	1.122	1.117	1.115	1.111	1.106	1.103	1.101
–40	1.147	1.142	1.140	1.134	1.128	1.122	1.117	1.111	1.110	1.106	1.101	1.099	1.097
–35	1.140	1.135	1.134	1.128	1.122	1.116	1.112	1.106	1.105	1.101	1.096	1.094	1.092
–30	1.134	1.129	1.128	1.122	1.116	1.111	1.106	1.101	1.100	1.096	1.092	1.090	1.088
–25	1.127	1.122	1.121	1.115	1.110	1.105	1.100	1.095	1.094	1.091	1.087	1.085	1.083
–20	1.120	1.115	1.114	1.109	1.104	1.099	1.095	1.090	1.089	1.086	1.082	1.080	1.079
–15	1.112	1.109	1.107	1.102	1.097	1.093	1.089	1.084	1.083	1.080	1.077	1.075	1.074
–10	1.105	1.102	1.100	1.095	1.091	1.087	1.083	1.079	1.078	1.075	1.072	1.071	1.069
– 5	1.098	1.094	1.094	1.089	1.085	1.081	1.077	1.074	1.073	1.070	1.067	1.066	1.065
0	1.092	1.088	1.088	1.084	1.080	1.076	1.073	1.069	1.068	1.066	1.063	1.062	1.061
2	1.089	1.086	1.085	1.081	1.077	1.074	1.070	1.067	1.066	1.064	1.061	1.060	1.059
4	1.086	1.083	1.082	1.079	1.075	1.071	1.068	1.065	1.064	1.062	1.059	1.058	1.057
6	1.084	1.080	1.080	1.076	1.072	1.069	1.065	1.062	1.061	1.059	1.057	1.055	1.054
8	1.081	1.078	1.077	1.074	1.070	1.066	1.063	1.060	1.059	1.057	1.055	1.053	1.052
10	1.078	1.075	1.074	1.071	1.067	1.064	1.061	1.058	1.057	1.055	1.053	1.051	1.050
12	1.075	1.072	1.071	1.068	1.064	1.061	1.059	1.056	1.055	1.053	1.051	1.049	1.048
14	1.072	1.070	1.069	1.066	1.062	1.059	1.056	1.053	1.053	1.051	1.049	1.047	1.046
16	1.070	1.067	1.066	1.063	1.060	1.056	1.054	1.051	1.050	1.048	1.046	1.045	1.044
18	1.067	1.065	1.064	1.061	1.057	1.054	1.051	1.049	1.048	1.046	1.044	1.043	1.042
20	1.064	1.062	1.061	1.058	1.054	1.051	1.049	1.046	1.046	1.044	1.042	1.041	1.040
22	1.061	1.059	1.058	1.055	1.052	1.049	1.046	1.044	1.044	1.042	1.040	1.039	1.038
24	1.058	1.056	1.055	1.052	1.049	1.046	1.044	1.042	1.042	1.040	1.038	1.037	1.036
26	1.055	1.053	1.052	1.049	1.047	1.044	1.042	1.039	1.039	1.037	1.036	1.036	1.034
28	1.052	1.050	1.049	1.047	1.044	1.041	1.039	1.037	1.037	1.035	1.034	1.034	1.032
30	1.049	1.047	1.046	1.044	1.041	1.039	1.037	1.035	1.035	1.033	1.032	1.032	1.030
32	1.046	1.044	1.043	1.041	1.038	1.036	1.035	1.033	1.033	1.031	1.030	1.030	1.028
34	1.043	1.041	1.040	1.038	1.036	1.034	1.032	1.031	1.030	1.029	1.028	1.028	1.026
36	1.039	1.038	1.037	1.035	1.033	1.031	1.030	1.028	1.028	1.027	1.025	1.025	1.024
38	1.036	1.035	1.034	1.032	1.031	1.029	1.027	1.026	1.025	1.025	1.023	1.023	1.022
40	1.033	1.032	1.031	1.029	1.028	1.026	1.025	1.024	1.023	1.023	1.021	1.021	1.020
42	1.030	1.029	1.028	1.027	1.025	1.024	1.023	1.022	1.021	1.021	1.019	1.019	1.018
44	1.027	1.026	1.025	1.023	1.022	1.021	1.020	1.019	1.019	1.018	1.017	1.017	1.016
46	1.023	1.022	1.022	1.021	1.020	1.018	1.018	1.017	1.016	1.016	1.015	1.015	1.014
48	1.020	1.019	1.019	1.018	1.017	1.016	1.015	1.014	1.014	1.013	1.013	1.013	1.012
50	1.017	1.016	1.016	1.015	1.014	1.013	1.013	1.012	1.012	1.011	1.011	1.011	1.010
52	1.014	1.013	1.012	1.012	1.011	1.010	1.010	1.009	1.009	1.009	1.009	1.009	1.008
54	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.007	1.007	1.006	1.006	1.006
56	1.007	1.007	1.006	1.006	1.005	1.005	1.005	1.005	1.005	1.005	1.004	1.004	1.004
58	1.003	1.003	1.003	1.003	1.003	1.003	1.002	1.002	1.002	1.002	1.002	1.002	1.002
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
62	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.998	0.998	0.998	0.998
64	0.993	0.993	0.994	0.994	0.994	0.994	0.995	0.995	0.995	0.995	0.996	0.996	0.996
66	0.990	0.990	0.990	0.990	0.991	0.992	0.992	0.993	0.993	0.993	0.993	0.993	0.993
68	0.986	0.986	0.987	0.987	0.988	0.989	0.990	0.990	0.990	0.990	0.991	0.991	0.991
70	0.983	0.983	0.984	0.984	0.985	0.986	0.987	0.988	0.988	0.988	0.989	0.989	0.989
72	0.979	0.980	0.981	0.981	0.982	0.983	0.984	0.985	0.986	0.986	0.987	0.987	0.987
74	0.976	0.976	0.977	0.978	0.980	0.980	0.982	0.983	0.983	0.984	0.985	0.985	0.985
76	0.972	0.973	0.974	0.975	0.977	0.978	0.979	0.980	0.981	0.981	0.982	0.982	0.983
78	0.969	0.970	0.970	0.972	0.974	0.975	0.977	0.978	0.978	0.979	0.980	0.980	0.981
80	0.965	0.967	0.967	0.969	0.971	0.972	0.974	0.975	0.976	0.977	0.978	0.978	0.979
82	0.961	0.963	0.963	0.966	0.968	0.969	0.971	0.972	0.973	0.974	0.976	0.976	0.977
84	0.957	0.959	0.960	0.962	0.965	0.966	0.968	0.970	0.971	0.972	0.974	0.974	0.975
86	0.954	0.956	0.956	0.959	0.961	0.964	0.966	0.967	0.968	0.969	0.971	0.971	0.972
88	0.950	0.952	0.953	0.955	0.958	0.961	0.963	0.965	0.966	0.967	0.969	0.969	0.970
90	0.946	0.949	0.949	0.952	0.955	0.958	0.960	0.962	0.963	0.964	0.967	0.967	0.968
92	0.942	0.945	0.946	0.949	0.952	0.955	0.957	0.959	0.960	0.962	0.964	0.965	0.966
94	0.938	0.941	0.942	0.946	0.949	0.952	0.954	0.957	0.958	0.959	0.962	0.962	0.964
96	0.935	0.938	0.939	0.942	0.946	0.949	0.952	0.954	0.955	0.957	0.959	0.960	0.961
98	0.931	0.934	0.935	0.939	0.943	0.946	0.949	0.952	0.953	0.954	0.957	0.957	0.959
100	0.927	0.930	0.932	0.936	0.940	0.943	0.946	0.949	0.950	0.952	0.954	0.955	0.957
105	0.917	0.920	0.923	0.927	0.931	0.935	0.939	0.943	0.943	0.946	0.949	0.949	0.951
110	0.907	0.911	0.913	0.918	0.923	0.927	0.932	0.936	0.937	0.939	0.943	0.944	0.946
115	0.897	0.902	0.904	0.909	0.915	0.920	0.925	0.930	0.930	0.933	0.937	0.938	0.940
120	0.887	0.892	0.894	0.900	0.907	0.912	0.918	0.923	0.924	0.927	0.931	0.932	0.934
125	0.876	0.881	0.884	0.890	0.898	0.903	0.909	0.916	0.916	0.920	0.925	0.927	0.928
130	0.865	0.871	0.873	0.880	0.888	0.895	0.901	0.908	0.909	0.913	0.918	0.921	0.923
135	0.854	0.861	0.863	0.871	0.879	0.887	0.894	0.901	0.902	0.907	0.912	0.914	0.916
140	0.842	0.850	0.852	0.861	0.870	0.879	0.886	0.893	0.895	0.900	0.905	0.907	0.910

EXAMPLE: A container has in it 4,055 gal of LP-Gas with a specific gravity of 0.560 at a liquid temperature of 75°F. The correction factors in the 0.560 column are 0.980 at 76°F and 0.983 at 74°F, or, interpolating, 0.9815 for 75°F. The volume of liquid at 60°F is 4,055 × 0.9815, or 3980 gal.

E-3.2.2 To determine the volume in gal of a particular LP-Gas at temperature "t" to correspond with a given number of gal at 60°F, Table E-3.1.3 is used as follows:

(a) Obtain the correction factor for the LP-Gas, using the column for its specific gravity and reading the factor for temperature "t."

(b) *Divide* the number of gal at 60°F by this correction factor to obtain the volume at temperature "t."

EXAMPLE: It is desired to pump 800 gal at 60°F into a container. The LP-Gas has a specific gravity of 0.510 and the liquid temperature is 44°F. The correction factor in the 0.510 column for 44°F is 1.025. Volume to be pumped at 44°F is 800 ÷ 1.025 = 780 gal.

E-4 Maximum Liquid Volume Computations.

E-4.1 Maximum Liquid LP-Gas Content of a Container at Any Given Temperature.

E-4.1.1 The maximum liquid LP-Gas content of any container depends upon the size of the container, whether it is installed avoveground or underground, the maximum permitted filling density and the temperature of the liquid [*see Tables 4-5.2.3(a), (b) and (c)*.]

E-4.1.2 The maximum volume "V_t (in percent of container capacity) of an LP-Gas at temperature "t," having a specific gravity "G" and a filling density of "L," is computed by use of the formula:

$$V_t = \frac{L}{G} \div F, \text{ or } V_t = \frac{L}{G \times F} \text{ where:}$$

V_t = percent of container capacity which may be filled with liquid
L = filling density
G = specific gravity of particular LP-Gas
F = correction factor to correct volume at temperature "t" to 60°F.

EXAMPLE 1: The maximum liquid content, in percent of container capacity, for an aboveground 500 gal water capacity container of an LP-Gas having a specific gravity of 0.550 and at a liquid temperature of 45°F is computed as follows:

From Table 4-5.2.1, L = 0.47, and from Table E-3.1.3, °F = 1.019

$$\text{Thus } V_{45} = \frac{0.47}{0.550 \times 1.019} = 0.838\ (83\%)\text{, or 415 gallons}$$

EXAMPLE 2: The maximum liquid content, in percent of container capacity, for an aboveground 30,000 gal water capacity container of LP-Gas having a specific gravity of 0.508 and at a liquid temperature of 80°F is computed as follows:

From Table 4-5.2.1, L = 0.45, and from Table E-3.1.3, °F = 0.967

$$\text{Thus } V_{80} = \frac{0.45}{0.508 \times 0.967} = 0.915\ (91\%)\text{, or 27,300 gallons}$$

E-4.2 Alternate Method of Filling Containers.

E-4.2.1 Containers equipped only with fixed maximum level gauges or only with variable liquid level gauges, when temperature determinations are not practical, may be filled with either gauge provided the fixed maximum liquid level gauge is installed, or the variable gauge is set, to indicate the volume equal to the maximum permitted filling density as provided in 4-5.3.3(a). This level is computed on the basis that the liquid temperature will be 40°F for aboveground containers, or 50°F for underground containers.

E-4.2.2 The percentage of container capacity which may be filled with liquid is computed by use of the formula shown in E-4.1.2, substituting the appropriate values as follows:

$$V_t = \frac{L}{G \times F}\text{, where:}$$

t = the liquid temperature. Assumed to be 40°F for aboveground containers or 50°F for underground containers.

L = the loading density obtained from Table 4-5.2.1 for:

(1) the specific gravity of the LP-Gas to be contained.

(2) the method of installation, aboveground or underground, and if aboveground, then:

(a) for containers of 1,200 gal water capacity or less.

(b) for containers of more than 1,200 gal water capacity.

G = the specific gravity of the LP-Gas to be contained.

F = the correction factor. Obtained from Table E-3.1.3, using G and 40°F for aboveground containers or 50°F for underground containers.

EXAMPLE: The maximum volume of LP-Gas with a specific gravity of 0.550 which may be in a 1,000 gal water capacity aboveground container which is filled by use of a fixed maximum liquid level gauge is computed as follows:

t is 40°F for an aboveground container.

L for 0.550 specific gravity, and an aboveground container of less than 1,200 gal water capacity, from Table 4-5.2.1, is 47 percent.

G is 0.550.

F for 0.550 specific gravity at 40°F from Table E-3.1.3 is 1.025.

$$\text{Thus, } V_{40} = \frac{.47}{0.550 \times 1.025} = 0.834\ (83\%)\text{, or 830 gallons.}$$

E-4.2.3 Percentage values, such as in the example in E-4.2.2, are rounded off to the next lower full percentage point, or to 83 percent in this example.

E-4.3 Location of Fixed Maximum Liquid Level Gauges in Containers.

E-4.3.1 Due to the diversity of fixed liquid gauges, and the many sizes (from DOT cylinders to 120,000 gal ASME vessels) and types (vertical, horizontal, cylindrical and spherical) of containers in which gauges are installed, it is not possible to tabulate the liquid levels such gauges should indicate for the maximum permitted filling densities [*see Table 4-5.2.1 and 4-5.3.3(a)*].

E-4.3.2 The percentage of container capacity which these gauges should indicate is computed by use of the formula in E-4.1.2. The liquid level this gauge should indicate is obtained by applying this percentage to the water capacity of the container in gal (water at 60°F), then using the strapping table for the container (obtained from its manufacturer) to determine the liquid level for this gallonage. If such a table is not available, this liquid level is computed from the internal dimensions of the container, using data from engineering handbooks.

E-4.3.3 The formula of E-4.1.2 is used to determine the maximum LP-Gas liquid content of a container to comply with Table 4-5.2.1 and 4-5.3.3(a), as follows:

Volumetric percentage, or $V_t = \frac{L}{G \times F}$, and

Volume in Gallons = $V_t \times$ Container Gallons Water Capacity, or

$$\text{Vol. in Gal. at } t = \frac{\text{L (Table 4-2)} \times \text{Container Gallons Water Capacity}}{\text{G (Spec. Grav.)} \times \text{F (For G and at temperature t)}}$$

EXAMPLE 1: Assume a 100 gal water capacity container for underground storage of propane with a specific gravity of 0.510. From Table 4-5.2.1, L = 46 percent; from 4-5.3.3(a), t = 50°F; and from Table E-3.1.3, °F for 0.510 specific gravity and a temperature of 50°F is 1.016; or

$$\text{Vol. in Gal. at 50 F} = \frac{.46 \times 100}{0.510 \times 1.016} = 88.7 \text{ gallons}$$

EXAMPLE 2: Assume an 18,000 gal water capacity container for aboveground storage of a mixture with a specific gravity of 0.550. From Table 4-5.2.1, L = 50 percent; from 4-5.3.3(a), t = 40°F; and from Table E-3.1.3, °F for 0.550 specific gravity and 40°F temperature is 1.025; or

$$\text{Vol. in Gal. at 40 F} = \frac{.50 \times 18{,}000}{0.550 \times 1.025} = 15{,}950 \text{ gallons}$$

Appendix F Wall Thickness of Copper Tubing

This Appendix is not a part of the requirements of this NFPA document. . .but is included for information purposes only.

Table F-1 Wall Thickness of Copper Tubing

(Standard Specification for Copper Water Tube, ASTM B88)

Standard Size Inches	Nominal OD Inches	Nominal Wall Thickness Inches Type K	Type L
¼	0.375	0.035	0.030
⅜	0.500	0.049	0.035
½	0.625	0.049	0.040
⅝	0.750	0.049	0.042
¾	0.875	0.065	0.045

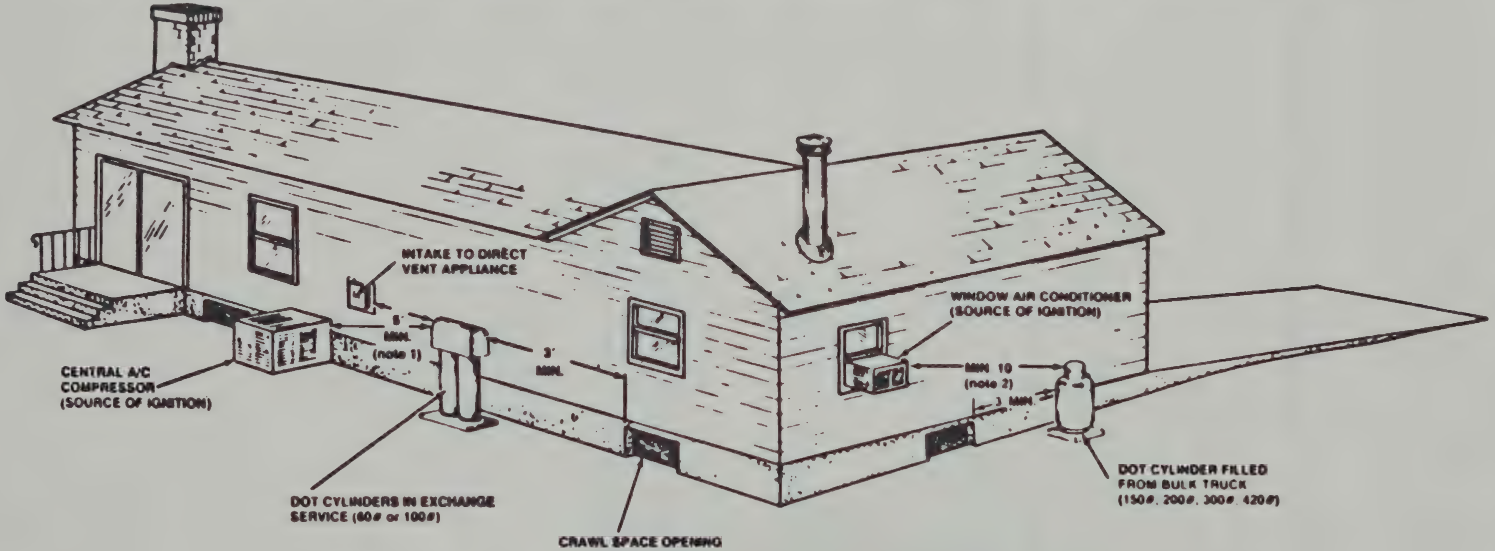
Table F-2 Wall Thickness of Copper Tubing

(Standard Specification for Seamless Copper Tubing for
Air Conditioning and Refrigeration Field Service, ASTM B280)

Standard Size Inches	Outside Diam. Inches	Wall Thickness Inches
¼	0.250	0.030
5/16	0.312	0.032
⅜	0.375	0.032
½	0.500	0.032
⅝	0.625	0.035
¾	0.750	0.042
⅞	0.875	0.045

Appendix G Container Spacing

This Appendix is not a part of the requirements of this NFPA document. . .but is included for information purposes only.

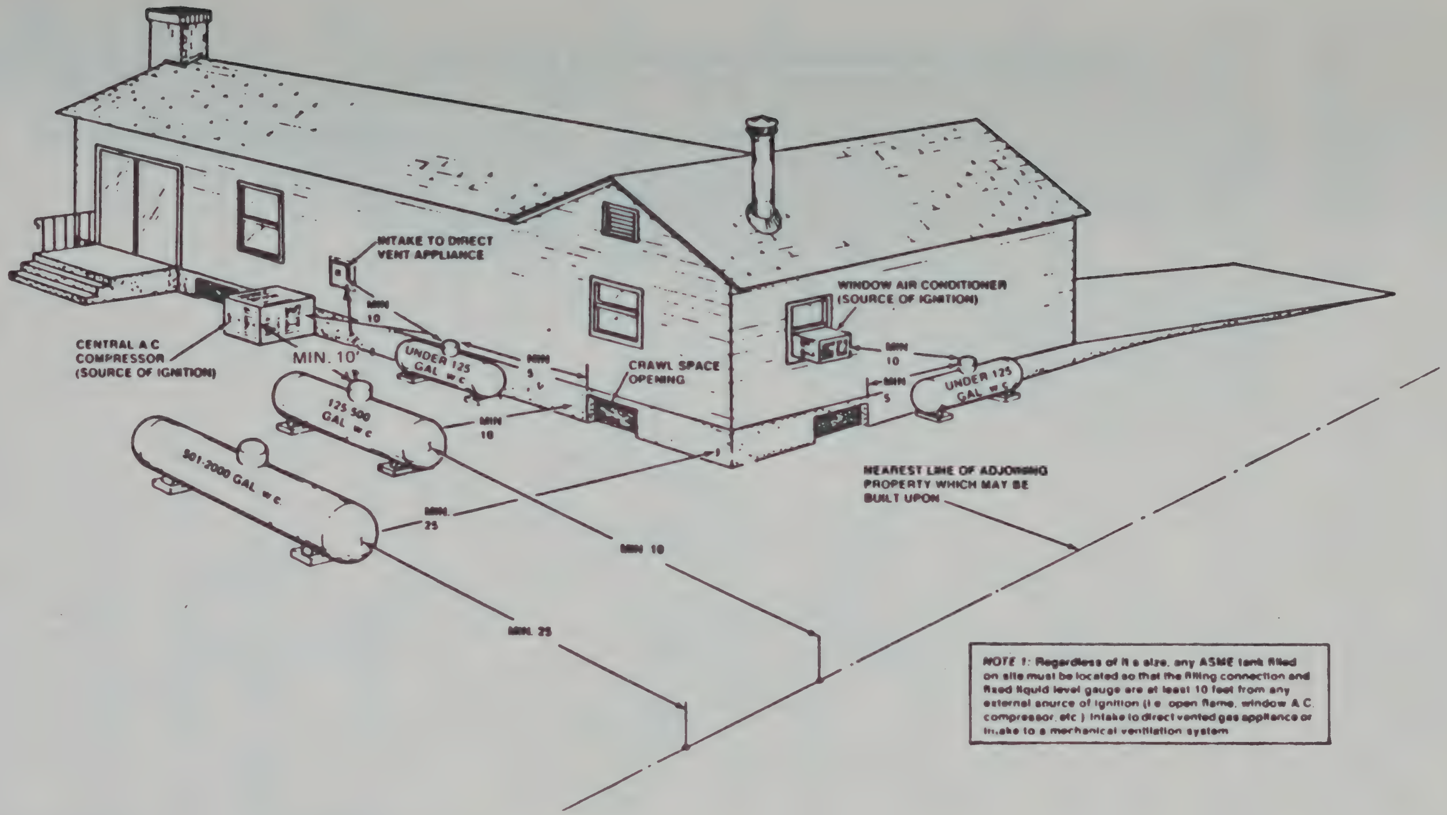

INTAKE TO DIRECT VENT APPLIANCE
5' MIN. (note 1)
3' MIN.
WINDOW AIR CONDITIONER (SOURCE OF IGNITION)
MIN 10 (note 2)
3 MIN.
CENTRAL A/C COMPRESSOR (SOURCE OF IGNITION)
DOT CYLINDERS IN EXCHANGE SERVICE (60# or 100#)
CRAWL SPACE OPENING
DOT CYLINDER FILLED FROM BULK TRUCK (150#, 200#, 300#, 420#)

(For SI Units: 1 ft = 0.3048 m)

NOTE 1: 5 foot minimum between relief valve discharge and external source of ignition (air conditioner), direct vent, or mechanical ventilation system (attic fan)

NOTE 2. If the DOT cylinder is filled on-site from a bulk truck the filling connection and vent valve must be at least 10 feet from any external source of ignition, direct vent, or mechanical ventilation system.

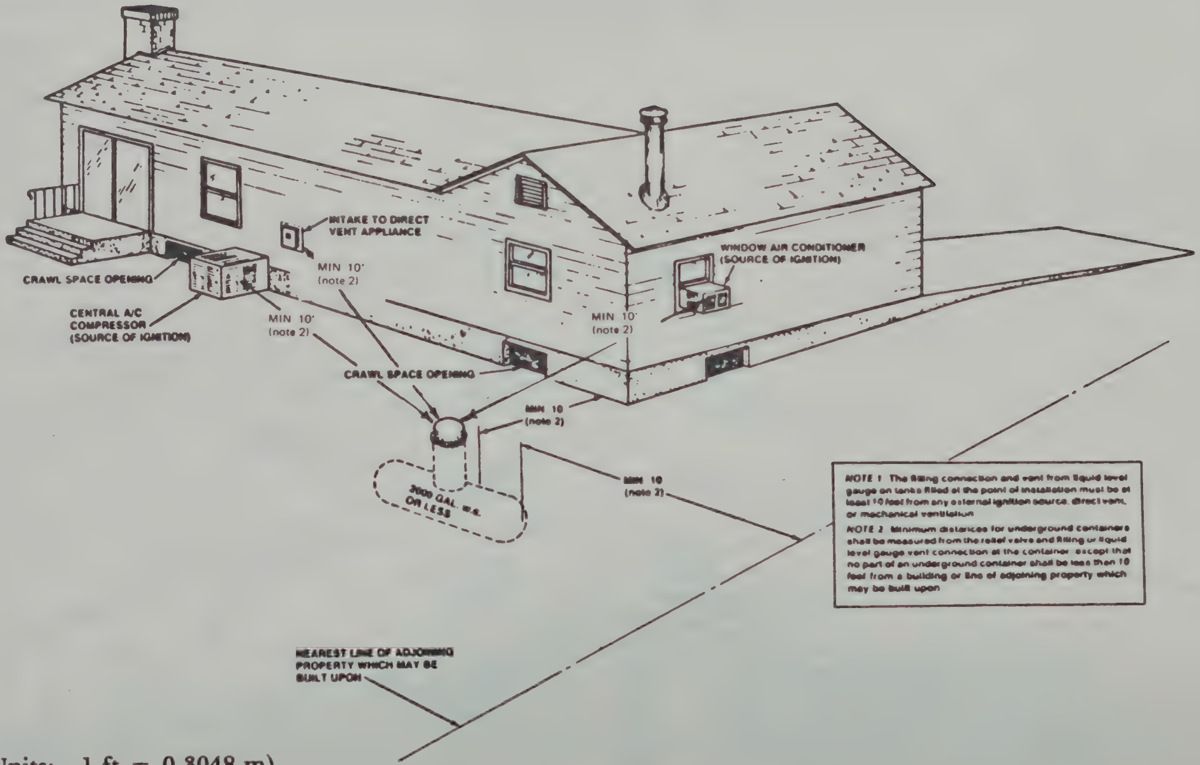
Figure G-1 DOT Cylinders
(This figure for illustrative purposes only; text shall govern.)


INTAKE TO DIRECT VENT APPLIANCE
WINDOW AIR CONDITIONER (SOURCE OF IGNITION)
CENTRAL A.C COMPRESSOR (SOURCE OF IGNITION)
MIN 10
MIN. 10'
UNDER 125 GAL w.c.
MIN 5
CRAWL SPACE OPENING
MIN 10
UNDER 125 GAL w.c.
MIN 5
125-500 GAL w.c.
MIN 10
501-2000 GAL w.c.
MIN. 25
MIN 10
MIN. 25
NEAREST LINE OF ADJOINING PROPERTY WHICH MAY BE BUILT UPON

NOTE 1: Regardless of it's size, any ASME tank filled on site must be located so that the filling connection and fixed liquid level gauge are at least 10 feet from any external source of ignition (i.e. open flame, window A.C. compressor, etc.) intake to direct vented gas appliance or intake to a mechanical ventilation system.

(For SI Units: 1 ft = 0.3048 m)

Figure G-2 Aboveground ASME Tanks
(This figure for illustrative purposes only; text shall govern.)


INTAKE TO DIRECT VENT APPLIANCE
WINDOW AIR CONDITIONER (SOURCE OF IGNITION)
CRAWL SPACE OPENING
CENTRAL A/C COMPRESSOR (SOURCE OF IGNITION)
MIN 10' (note 2)
MIN 10' (note 2)
MIN 10' (note 2)
CRAWL SPACE OPENING
MIN 10 (note 2)
MIN 10 (note 2)
2000 GAL. w.c. OR LESS
NEAREST LINE OF ADJOINING PROPERTY WHICH MAY BE BUILT UPON

NOTE 1 The filling connection and vent from liquid level gauge on tanks filled at the point of installation must be at least 10 feet from any external ignition source, direct vent, or mechanical ventilation

NOTE 2 Minimum distances for underground containers shall be measured from the relief valve and filling or liquid level gauge vent connection at the container except that no part of an underground container shall be less than 10 feet from a building or line of adjoining property which may be built upon

(For SI Units: 1 ft = 0.3048 m)

Figure G-3 Underground ASME Tanks
(This figure for illustrative purposes only; text shall govern.)

Appendix H Referenced Publications

H-1 This portion of the Appendix lists publications referenced within this NFPA document and thus is considered part of the requirements of the document.

H-1.1 NFPA Publications. The following publications are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1981, *Standard for Portable Fire Extinguishers.*

NFPA 30-1981, *Flammable and Combustible Liquids Code.*

NFPA 321-1982, *Basic Classification of Flammable and Combustible Liquids.*

NFPA 37-1979, *Stationary Conbustion Engines and Gas Turbines.*

NFPA 50-1979, *Bulk Oxygen Systems at Consumer Sites.*

NFPA 50A-1978, *Gaseous Hydrogen Systems at Consumer Sites.*

NFPA 50B-1978, *Liquefied Hydrogen Systems at Consumer Sites.*

NFPA 51-1983, *Oxygen-Full Gas Systems for Welding, Cutting and Allied Presses.*

NFPA 54 (ANSI Z223.1)-1980, *National Fuel Gas Code.*

NFPA 59-1979, *LP-Gases at Utility Gas Plants.*

NFPA 61B-1980, *Prevention of Fires and Explosions in Grain Elevators and Facilities Handling Bulk Raw Agricultural Commodities.*

NFPA 70-1981, *National Electrical Code.*

NFPA 77-1983, *Static Electricity.*

NFPA 78-1980, *Lightning Protection Code.*

NFPA 80-9181, *Fire Doors and Windows.*

NFPA 82-1983, *Incinerators, Waste and Linen Handling Systems and Equipment.*

NFPA 86A-1982, *Ovens and Furnaces.*

NFPA 96-1980, *Removal of Smoke & Gases Laden Vapors from Commercial Cooking Equipment.*

NFPA 251-1979, *Standard Methods of Fire Tests of Buiulding Construction and Materials.*

NFPA 302-1980, *Fire Protection Standard for Motor Craft.*

NFPA 501A-1982, *Firesafety Criteria for Mobile Home Installations, Sites and Communities.*

NFPA 501C-1982, *Firesafety Criteria for Recreational Vehicles.*

NFPA 505-1982, *Powered Industrial Trucks.*

H-1.2 ANSI Publications. The following publications are available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI A 58.1-1972, *Building Code Requirements for Minimum Design Loads in Buildings and Other Structures.*

ANSI B 36.10-1979, *Welded and Seamless Wrought Steel Pipe.*

ANSI B 95.1-1977, *Standard Terminology for Pressure Relief Devices.*

H-1.3 ASTM Publications. The following publications are available from the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

A-47-1977, *Specification for Malleable Iron Castings.*

A-48-1976, *Specification for Gray Iron Castings.*

A-53-1980, *Specification for Welded and Seamless Pipe, Steel, Black and Hot-Dipped, Zinc Coated.*

A-106-1980, *Specification for Seamless Carbon Steel Pipe for High Temperature Service.*

A-120-1980, *Specification for Welded and Seamless Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized).*

A-395-1980, *Specification for Ferritic Ductile Iron Pressure - Retaining Castings for Use at Elevated Temperatures.*

A-536-1980, *Specification for Ductile Iron Castings.*

A-539-1979, *Specification for Electric - Resistance - Welded Coiled Steel Tubing for Gas and Fuel Oil Lines.*

B-42-1981, *Specification for Seamless Copper Pipe, Standard Sizes.*

B-43-1980, *Specification for Seamless Red Brass Pipe, Standard Sizes.*

B-88-1981, *Specification for Seamless Copper Water Tube.*

B-135-1981, *Specification for Seamless Brass Tube.*

B-280-1980, *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.*

D-2513-1980a, *Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.*

D-2683-1980, *Specification for Socket-Type Polyethylene (PE) Fittings for Outside Diameter-Controlled Polyethylene Pipe.*

D-3261-1978, *Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.*

H-1.4 CGA Publications. The following publications are available from the Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

ANSI 748.1 (CGA C-4)-1978, *Method of Marking Portable Compressed Gas Cylinders to Identify the Material Contained.*

Pressure-Relief Device Standards - 1963,

S-1.1, *Cylinders for Compressed Gases.*

S-1.2, *Cargo and Portable Tanks for Compressed Gases.*

S-1.3, *Compressed Gas Storage Containers.*

H-1.5 ASME Publications. The following publication is available from the American Society for Mechanical Engineers, 345 East 47th St., New York, NY 10017.

Rules for the Construction of Unfired Pressure Vessels, Section VIII, Division 1, *ASME Boiler and Pressure Vessel Code* - 1980.

H-1.6 API Publication. The following publication is available from the American Petroleum Institute, 2101 L ST., NW, Washington, DC 20037.

API-ASME *Code for Unfired Pressure Vessels* - Pre - July 1, 1961.

H-1.7 Federal Regulations. The following publications are available from the US Government Printing Office, Washington, DC.

Code of Federal Regulations, Title 49, Parts 171-190. (Also available from the Associatiion of American Railroads, American Railroads Bldg., 1920 L St. NW, Washington, DC 20036 and American Trucking Assn, Inc., 1916 P. St. NW, Washington, DC 20036.

Code of Federal Regulations, Title 49, Parts 191 and 192.

H-1.8 ICBO Publication. The following publication is available from the International Conference of Building Officials, 5360 S. Workman Mill Rd., Whittier, CA 90601

Uniform Building Code - 1976.

H-1.9 UL Publication. The following publication is available from Underwriters Laboratories, Inc., 333 Pfingston Rd., Northbrook, IL 60062.

UL 132-, *Safety Relief Valves for Anhydrous Ammonia and LP-Gas.*

H-1.10 AWS Publications. The following publication is available from the American Welding Society, 2501 NW 7th St., Miami, FL 33125.

ANSI Z49.1-1973, *Safety in Welding and Cutting.*

H-2 This portion of the appendix lists publications referenced within this NFPA document for information purposes only and thus is not considered part of the requirements of the document.

H-2.1 NLPGA Publications. The following publications are available from the National LP-Gas Association, 1301 W. 22nd St., Oak Brook, IL 60521.

Recommendations for Prevention of Ammonia Contamination of LP-Gas.

Safety Bulletin 118-79, Recommended Procedures for Visual Inspection and Requalification of DOT (ICC) Cylinders in LP-Gas Service.

H-2.2 CGA Publication. The following publication is available from the Compressed Gas Association, Inc., 1235 Jefferson Davis Highway, Arlington, VA 22202.

CGA Pamphlet C-6-1980, *Standard for Visual Inspection of Compressed Gas Cylinders.*

H-2.3 API Publication. The following publication is available from the American Petroleum Institute, 2101 L St., NW, Washington, DC 20037.

API Standard 2510-1978, *The Design and Construction of Liquefied Petroleum Gas Installations at Marine and Pipeline Terminals, National Gas Processing Plants, Refineries, Petrochemical Plants and Tank Farms.*

H-2.4 Federal Publication. The following publication is available from the National Technical Information Service, US Dept. of Commerce, Springfield, VA 221612.

BERC/RI-77/1, Spetember 1977, *A New Look at Odorization Levels for Propane Gas, United States Energy & Development Administration, Technical Information Center.*

Index

A

- **Aboveground containers**
  - Installation 3-2.3
  - Location 3-2.2
  - Painting 3-2.3.1(f)
  - Relief valves 2-3.2.4
- **Access, container appurtenances** 3-2.3.1(d)
- **Access roadway** 3-3.3.3, 3-10.2.6
- **Accessories, containers** 2-3.1, 2-3.1.2, 2-3.3.2, 3-2.4.6, 6-3.2.1
- **Agricultural air moving equipment, shut down** 3-8.4.2(a)
- **Agricultural heaters** 2-6.3.2
- **Air for combustion** 3-6.4.2(b), 3-6.5.4(b), 3-9.4.2
- **Ammonia contamination** 1-2.1.2
- **Anchorage of containers against flood** 3-2.2.5(g)
- **API — ASME Code**
  - Containers to conform to 2-2.1
  - Vaporizers to conform to 2-5.4
- **Appliance installation** 3-5.1, 3-9.4
- **Appliances for use on vehicles** 2-6.3.5, 3-9.4
  - Accessibility 3-9.4.2(e)
- **Appliances for use in mobile homes, travel trailers, camper trailers, and self-propelled campers** 2-6.3.4
- **Appliances to be approved** 2-6.2
- **Application of standard** 1-2.2.1
  - Approval, definition 1-7
- **Approval, provisions for** Table 1-3
  - Appliances 2-6.3
  - Appliances for commercial vehicles 2-6.3.5, 3-9.4
  - Equipment and systems 1-3.1
  - Mobile homes, travel trailers, camper trailers, and self-propelled campers 2-6.3.4
- **ASME Code**
  - Containers to conform to 2-2.1
  - Vaporizers to conform to 2-5.4
- **Atmospheric vaporizers** 3-7.2.9
- **Attendant**
  - At transfer connection 4-2.1
- **Automatic shutoff** 3-6.2.4(d), 3-6.2.9(c)(2), 3-6.5.4, 3-6.5.6(a)
  - Portable engines in buildings 3-6.5.2(b)

B

- **Back flow check valve**
  - At tank car or truck unloading points 3-2.7.9(a), 3-3.3.4(a)
  - On cylinder system containers 2-3.3.2, 2-3.3.3, Table 2-3.4.2, 3-2.4.6(a)(1)
  - Cargo tank 2-3.3.3, 6-3.2.1(d)(2)
- **Blow-off lines** 3-3.4.6
- **Buildings**
  - Containers inside 3-2.5.4, 3-4
  - Containers to be outside 3-2.2.1
  - Construction 7-2.1
  - Gas mfg. and distributing 3-2.2.4, 7-1.1
  - Industrial 3-4.5
  - Piping liquid in 3-2.6.1
  - Under construction 3-4.3, 3-4.4
- **Buildings frequented by the public** 3-4.1.1, 3-4.4.1
- **Bulk filling plants** 3-3
- **Bulk storage in congested areas** 3-2.2.3
- **Bumpers**
  - Protecting motor fuel containers 3-6.2.6(a)
- **Buried containers**
  - Installation 3-2.2.5(g), 3-2.3.8, 3-2.3.9
  - Markings 2-2.6.5
- **Buses, fuel containers on** 3-9.2.3(d)

C

- **Capacity limit of**
  - Containers at service stations 2-2.1.5
  - Containers inside buildings 3-4.2
  - Containers other than DOT 2-2.1.5
  - Cylinders awaiting use 5-1.1.1
  - Motor fuel system containers 3-9.2.1
- **Car unloading (RR)** 3-3.3.3
- **Cargo cooler** 3-9.4.2(a)
- **Cargo heater** 3-9.4.2(a)
- **Cargo tanks**
  - Marking 6-3.6.1
  - Painting 6-3.6.1
- **Caution plate**
  - Commercial vehicles 3-9.4.2(g)
- **Charging, containers on vehicles** 3-9.5.1, 4-2.2.2, 4-3.3.2
- **Charging plant, location** 3-3.3, 3-3.4.5, 4-3.3.2

- **Check valve in unloading line** 2-3.3.3, 3-2.7.9, 3-3.3.4
- **Chemical plants** .... 1-2.3.1(d)
- **Chock blocks** 6-3.8
- **Chock blocks for tank trucks and trailers** 6-3.8.1
- **Classification of containers**
  - Cargo tanks 6-3.2.1
  - Motor fuel 2-2.2.2, 3-9.2.1
  - Other than DOT 2-2.2.2
  - Service station tanks .... 2-2.2.3, Table 2-2.2.2
- **Classified areas, electrical equipment in** 3-8.2.2, 3-8.2.3
- **Collision protection**
  - Motor fuel container valves and connections 3-6.2.6
  - Tank trucks and trailers 6-3.5.1
- **Combustible limits of LP-Gas** . 1-1.1.1
- **Combustible material near containers** .... 3-2.2.5(b), 3-2.3.4(a)
- **Combustion air**
  - Commercial vehicles 3-9.4.2(f), 3-9.4.2(e)
  - Motor fuel .... 3-6.4.2(b), 3-6.5.4(b)
- **Commercial systems**
  - Approval .... 1-3.1, Table 1-3
- **Commercial vehicle container mounting requirements** ..... 2-6.3.5, 3-9.2.2, 3-9.2.3(a), (b)
- **Compressors — Transfer** 2-5.3, 4-2.3.1, 4-2.3.2, 3-3.4.5
- **Condensation in piping** 3-2.7.7
- **Congested areas, bulk storage in** . . 3-2.2.3
- **Connections, flexible** (*see Flexibility in connections*)
- **Connections, testing** . . . 3-2.9.1
- **Construction, commercial vehicle heating appliances** 3-9.4.2, 2-6.3.5
- **Construction of containers**
  - Basic rules .... Appendix B
  - Commercial vehicles 3-9.2.1
- **Construction of cylinder storage rooms** 5-3.3.3, 7-3.1.1
- **Construction (building) operations** 3-4.1.1, 3-4.3
- **Container**
  - Appurtenance protection 2-2.4
  - Appurtenances ...... 2-3, Table 2-3.4.2
  - Connections 2-3.3, 2-3.6
  - Design 2-2.2
  - Openings 2-2.3
  - Supports 2-2.5
  - Vertical 2-2.2.3, 2-2.5.3, 3-2.3.3
- **Container assembly, definition** 1-7
- **Container charging** .... 3-9.5, 4-5.2, 4-5.3, 4-3.2.1, 4-3.3.1, 4-3.3.2, Table 4-5.2.1
- **Container charging plants** . . 3-3.3, 3-3.4, 4-3.3.2, Table 4-5.2.1
- **Containers**
  - ASME, design . . . Appendix C
  - Capacity limit of
    - Awaiting use 5-1.1.1, 5-3.1.1, 5-3.2.1, 5-3.3
    - Motor fuel systems 3-6.2.2
    - Other than DOT 2-2.1.5
  - Construction and test 2-2.1.2, 2-2.1.3
  - Consumer site liquid transfer 4-3.2, 4-3.3
  - Corrosion protection .... 3-2.3.2(c), 3-2.3.8(c)
  - Definitions 1-7
  - Filling connection 2-3.3
  - Filling density limits 4-5.3
  - Heating or cooling coils in . . . 2-2.1.7
  - Inside buildings 3-4.1.1, 3-2.5.4
  - Installation of other than DOT 3-2.3.1, 3-2.3.2, 3-2.3.3
  - Interchangeable ..... Appendix C-3.1.2
  - Interconnections 3-2.7.5
  - Location
    - Basic rules 3-2.2
    - Commercial vehicles 3-9.2.2, 3-9.2.3
    - Cylinder system 3-2.3.1, 3-2.2.2
    - Motor fuel 3-6.2.6
  - Markings on 2-2.1.3, 2-2.6
  - Motor fuel 2-2.2.3, 3-9.2.3
  - Provision for expansion . . 3-2.7.5, 3-2.7.8
  - Reinstallation and reuse 2-2.4.1
  - Service stations 2-2.2.2
  - Stacking .... 3-2.2.5(a)
  - Valve arrangement — Multicontainer .... 3-2.4.6(c)
  - Valves and accessories
    - Cargo tanks 6-3.2.1
    - Commercial vehicles 3-9.2.3
    - Cylinder systems . . 3-2.4.6(c), 3-2.5.2
    - General . . . 2-3, Table 2-3.4.2, 3-2.4.6
    - Motor fuel systems 3-6.2.3
  - Valves to be approved 1-3.1.1
  - Welding on .... 2-2.1.6, 3-2.3.1(e)
- **Contraction, provision for** 3-2.7.5
- **Conversion of appliances to LP-Gas** 2-6.3.1
- **Corrosion, protection against** .... 3-2.7.7, 3-2.3.2(c), 3-2.3.8(c)
- **Covering underground containers** 3-2.3.8
- **Cylinder charging rooms — Electrical equipment and open flames** 3-8.2, 7-2.3.1

Cylinders stored
  Highway vehicles 5-3.2.2
  Not installed . . .5-1.1.1, 5-1.1.2, 5-4.1.1

D

Damage protection, underground tanks .... 3-2.3.8(a)
Definitions 1-7
Demonstrations, or public exhibitions 3-4.8
Department of Transportation 1-1.2.1
Design
  Cargo tanks 6-3.2.1
  Commercial vehicles (systems) 3-9.1.1
  Container, general rules for . 2-2.1
  Containers other than DOT 2-2.1.3, 2-2.2.2
  Hose 2-4.6
  Motor fuel containers 2-2.2.3
  Service station . . .2-2.2.3, Table 2-2.2.2
  Valves and accessories 2-3.1, 2-4.5
  Vaporizers . . 3-6.2.4(b), 2-5.4
Differential regulator 6-3.4.5
Dikes ....3-2.2.5(c), (d), 3-2.2.6
Direct fired vaporizers 2-5.4.3
Discharge of relief valves
  Cargo tanks ....3-2.4.3, 6-3.2.1(a)
  Cylinder systems 2-5.8.1
  General rules 2-3.2.3, 3-2.4.1
  Motor fuel containers .... 3-6.2.6(i)
  Systems utilizing containers other than DOT 3-2.4.2, 3-2.4.3
Dispensing devices 2-5.7
  Hose 2-5.7.3
  Location ....4-3.3.2, Table 4-3.3.2, 3-2.10.6(b)
  Venting ....3-2.10.6(e)
Dispensing fuel
  Motor vehicles 3-2.10.6
Distance (min.) between LP-Gas containers — Flammable liquid tanks .... 3-2.2.5(e)
  Oxygen and hydrogen containers .... 3-2.2.5(f)
Drain from vaporizer of motor fuel system ....3-6.2.4(b)(3)
Drains to sewers 3-3.4.6
DOT containers
  Approval of systems using ... 1-3.1.1
  As motor fuel containers 3-9.2.1
  Filling density 4-5.3
  Storage indoors ....3-2.2.1, 3-4.2.1, 3-4.6.1(c), 3-4.3.9, 5-3
  To conform to DOT specifications 2-2.1.3

E

Education and institutional research 3-4.6, 3-4.8
Electrical equipment
  General rules 3-8.2
  In classified areas 3-8.2.2, 3-8.2.3
  Tank trucks and trailers 6-3.4.2
  Service stations 3-8.2.1, 3.8.2.2
Emergency heating 3-4.1.1, 3-4.7.1
Emergency shutoff valves ....2-4.5.3, 2-4.5.4, 3-3.3.4, 4-2.3.6, 6-3.2.1(a)
Enclosure of systems on commercial vehicles 3-9.2.2, 3-9.2.3
Engine fuel systems 3-6.1
Engines in buildings 3-6.3.1, 3-6.3.2
Equipment, LP-Gas 2-5
Excess flow valves
  By-pass .... 2-3.3.3(b)
  Cargo tanks 6-3.3.3, 2-3.3.2
  Containers other than DOT ....2-3.3.2, Table 2-3.4.2
  Cylinder system containers .. 2-3.3.2
  Location ....3-2.4.6(a), 3-9.4.2, Table 2-3.3.2, Note 4
  Motor fuel containers .... 3-6.2.3(a)
  Requirements for 2-3.3.3(b), 3-2.4.6(a)(3)
  Tank truck and trailer filling connections 6-3.4.5
  To be approved .....1-3.1.1, Table 1-3
Exhaust system on tank trucks 6-3.9
Expansion, provision for 3-2.7.5

F

Farm carts 6-4.3
Fencing 3-3.6.1
Field welding on
  Containers other than DOT ....2-2.1.6, 3-2.3.1(e)
  Motor fuel containers ....2-2.1, 2-2.2, 3-6.2.2(a)(2)
Filling by volume 2-2.3.2
Filling connections
  Containers other than DOT . 2-3.3.2
  Portable containers 2-2.3
Filling density 4-5.2.2
Fire doors, cylinder storage room ....7-3.2.1(b)(2) and 7-3.1.1(a)(2)
Fire extinguishers
  Bulk plant 3-10.2.7
  Mobile cooking unit 3-9.5.2
  Service stations 3-10.2.7
  Storage location 5-5.1.1
  Tank trucks 6-3.7.1
  Trucks 6-2.4.1

Fire protection 3-10, 5-5
  For storage installations 3-10
  Portable container locations 5-5.1
Fire walls 7-3.2.1
Fittings
  Design 2-4.4.1
  Materials permitted for 2-5.1.3, 2-4.4.1
  Prohibited 2-4.4.1
Fittings, piping and tubing
  Appliance systems on vehicles 3-9.2.7
  Motor fuel systems 3-6.2.3
  Service stations 2-4.4.1, 3-3.3.4
  Tank trucks and trailers 6-3.3.1
Flames, open 3-8.3.1, 3-8.3.2, 3-8.4.1(b), 3-8.4.2(b)
Flammable limits of LP-Gases 1-1.1.1, Table A-1.2.1
Flammable vapor indicators for pits 3-3.4.6
Flexibility in connections
  Cargo units 3-2.7.3, 6-3.3.4
  Commercial vehicles 3-9.2.7(a), (c)
  Internal combustion engines 3-6.2.3, 3-9.2.7(c)
  Motor fuel systems 3-6.2.3, 3-9.2.7(c)
  Storage tanks 3-2.7.5
Flexible Connectors 3-2.7.5, 2-4.6.3, 3-2.7.8, 6-3.3.4, 3-9.2.7(a), (c)
Floods, protection of containers against 3-2.2.5(g)
  Service stations 3-2.2.5(g)
Fork lift trucks 3-6.6
Foundation — Containers other than DOT 3-2.3.2
  Cylinder system containers 3-2.3.1(a)
  Service stations 3-2.3.2(a)¢(c), 2-2.5.2
Fuel containers
  Industrial trucks 3-6.6.2
Fuel from truck cargo tanks, use of 3-9.2.1(f)
Fuel, LP-Gas as motor 3-6.1, 3-6.4, 5-6.5, 3-6.6, 3-6.7
Fuse plugs on containers other than DOT 2-3.2.4(e), D-2.4.1, 3-6.2.3(a)(4), 3-9.2.1(b)(3)

G

Garaging
  LP-Gas fueled vehicles 3-6.6
  Tank vehicles 6-6.2.2
Gas, definition 1-7
Gas capacity of containers 4-5.2.2
Gas line 3-9.2.7, 3-2.6.1, 3-2.7.1
  Commercial vehicle 3-6.2.3
Gas manufacturing buildings 3-2.2.4
Gas transfer 4-1.1
Gauges, pressure 2-3.5
  Connections 2-3.5.2, 2-2.3.5
  Containers other than DOT 2-2.3.5, 3-2.4.6(f)
Gauging devices, liquid level
  Cargo tanks 6-3.2.1(e)
  Excess flow valves for 2-3.4.4
  Fixed tube 2-3.4.2
  Storage tanks 2-2.3.7, 4-5.3.3(b)
  To be approved 1-3.1.2, Table 1-3
Grandfather clause 1-2.4.1
Grass near containers 3-2.2.5(b), 3-2.3.4(a), 3-2.3.5(a)

H

Heaters, agricultural 2-6.3.2
Heating, emergency 3-4.1.1, 3-4.7.1
Heating of vaporizers 3-7.2
Hoods — may be approved 1-3.1.1
Hose
  Approval 2-4.6.2
  Dispensing 2-5.6.3
  Flexible — where permitted 2-4.6.4
  For flexibility 3-2.7.8(b)
  For regulators 3-2.7.10
  In buildings 3-4.2.4(b), 4-2.3.7
  Marking 2-4.6.3
  Specifications 2-4.6.1
  Test after assembly 2-4.5.3(b), 6-3.3.6
  Unloading 6-3.3.4, 4-2.3.4, 2-4.6.1, 3-3.3.4
Hydrostatic relief valves in piping
  Between shutoff valves 3-2.8.1, 2-4.7, 6-3.3.5

I

Identification of containers 2-2.6.2, 2-2.1.3
Ignition source, definition 1-7
Ignition source control 3-8.1
Illumination of containers and equipment 3-3.7.1
Indirect fired vaporizers 2-5.4.1, 2-5.4.2
Industrial, general 3-3.1
  Installations, large Table 3-2.2.2
Industrial portable space heating 3-4.7.1, 3-4.1.1, 3-4.5.2
Industrial processing, research 3-4.1.1, 3-4.5.1
Industrial trucks 4-3.3.1
  Changing containers 3-6.3.6(a)(2)
  Charging containers 3-6.3.6(a)
  Liquid level gauging 3-6.3.2(a)

- **Installation storage containers** 3-2.2.3, 3-2.3.3, 3-2.3.2
- **Institutional and educational research** 3-4.6
- **Instructions (training)** 1-6.1.1
- **Internal combustion engines** . . 3-8.3.1(a)
  - LP-Gas as fuel for 3-6.1, 3-6.4, 3-6.5, 3-6.6, 3-6.7
  - Vaporizers for . . . . 3-6.2.4(b)
- **Internal valves** . . . . 6-3.2.1(c), 2-3.3.1, 2-3.3.3(d)

J

- **Jarring, protection for** 3-2.7.5

L

- **Labels** — *See Markings*
- **Leakage tests** . . . . 3-2.9.1, 3-6.2.8(e), 3-9.2.7(i)
- **Lighting**
  - Bulk filling plants 3-3.7.1
  - General requirements (industrial 3-3.7.1
  - Industrial plants 3-3.7.1
  - Tank trucks and trailers 6-1.1.5
- **Lightning protection** 3-8.1.2
- **Limits of flammability** 1-1.1.1
- **Liquid evacuation conn.** 2-2.3.4
- **Liquid in buildings** 3-2.6.1, 3-4.2, 3-4.10
- **Liquid level gauging devices** . . 2-3.4.1
  - Excess flow valves for 2-3.4.4
  - Fixed . . . . 2-3.4.2, Appendix E-4.3
  - Industrial trucks . . . . 3-6.3.2(a)
- **Liquid piped in buildings** 3-2.6.1, 3-4.2, 3-4.10
- **Liquid transfer** . . . . Chapter 4
  - Use of hose . . . . 3-2.7.9(a)
- **Liquid volume correction factors** . . . . 4-5.3.2, Appendix E
- **Liquefied petroleum gases**
  - Definition 1-2.1.1
  - Hazards 1-1.1.1, 1-4.1.1, 4-2.1
  - Listed, definition 1-7
- **Listed system, repair or alteration** 2-2.1.5
- **Location**
  - Containers & regulating equipment . . . . . . 3-2.2, Table 3-2.2.2
  - Cylinder systems 3-2.3
  - Motor fuel containers 3-6.2.6
  - Unloading points 3-3.3, 4-3.1
  - Vaporizers 3-7.1
- **Location of LPG containers and systems on commercial vehicles** 3-9.2.2, 3-9.2.3
- **Location of**
  - Dispensing devices . . 4-3.3.2, Table 4-3.3.2, 3-2.10.6(b)
  - Service station containers . . . . 3-2.2, Table 3-2.2.2
  - Shutoff valves . . . . 3-2.4.6(a)(1)
- **Low pressure relief devices on cylinder systems** 3-2.5.3, 3-2.5.4

M

- **Manifold valve assemblies to be approved** . . . . Table 1-3
- **Marine terminals** . . . . 1-2.3.1(b)
- **Markings**
  - Cargo tanks 6-3.6.1
  - Commercial vehicles 6-2.2.8
  - Connections to containers other than DOT . . . . 3-2.4.6(e)
  - Container 2-2.6.1
  - Cylinder system container . . . 2-2.6.1
  - Liquid level gauges . . . . 2-3.4.2(a)
  - Relief valve . . . . 2-3.2.4(b)
  - Tank vehicles 6-3.6.1
  - Vaporizer . . . . 2-5.4.3(a), 3-6.2.4(b)
- **Maintaining containers** 2-2.1.4, 4-2.2.2
- **Metallic connections on tank trucks** 6-3.2.2
- **Meters** . . . 2-5.6, 3-2.10.5, 6-3.4.4, 6-3.4.5
- **Minimum distances between**
  - LPG and flammable liquid tanks . . . . 3-2.2.4(e)
  - LPG containers and buildings 3-2.2.2
  - LPG containers and oxygen and hydrogen containers . . 3-2.2.5(f)
  - LPG containers and property lines . . . . 3-2.2.2, Table 3-2.2.2
- **Mixing equipment** 3-6.2.2
  - Automatic shutoff . . . . 3-6.2.4(b)
  - Motor fuel 3-6.4.2
- **Mobile home appliances** 2-6.3.4
- **Mounting of tanks** 3-2.3.7
- **Mounting containers on tank trucks and trailers** 6-3.2.1
  - Commercial vehicles 3-9.2.2, 3-9.2.3, 2-6.3.5

N

- **Nameplate, system** 2-2.6
- **Nonapplicability of standard** . 1-2.3.1
- **Nonrefillable container** 4-2.2.3

O

Odorizing gases 1-4.1
  Amount required 1-4.1.1
Open flames restricted . . . . 3-8.2.1, 3-8.4.1(b), 3-8.3.2
  Cylinder storage rooms . . . . . 5-3.3.3(b)
Openings, plugged on containers other than DOT 2-2.3.3
Operations, construction . 3-4.1.1, 3-4.3.1
Original test-containers other than DOT 2-2.1.1, 2-2.1.3
Outdoor storage of cylinders 5-4.1.1, 5-1.1.1, 5-2.1
Owner's authorization to fill or use containers 4-2.2.1

P

Painting of aboveground containers . . . . 3-2.3.1(f)
  Cargo tanks 6-3.6.1
Parking
  Tank vehicles 6-6.2
Partially buried containers, installation 3-2.3.9
Permissible product in containers . . . . 4-2.2.4(a)
Personnel
  Qualification 1-6.1.1
  Training 1-6.1.1
  Transfer operations 4-2.1
Physical damage, protection against 6-3.5.1, 2-2.4.2
  Cargo tank 6-3.5.1, 2-2.4.2
  Motor fuel container valves and connections . . . 3-6.2.6, 6-3.2.1, 6-3.5.1
  Piping . . . . 3-2.7.6, 6-3.4.1(c)
  Service stations . . . . . . 3-2.3.1(c), 3-2.4.6
  Tank accessories 3-2.4.6
Pipe and tubing
  Copper . . . . 2-4.3.1, Appendix F
Pipe joints 3-2.7.1
Piping — General rules 2-4.2.1
  Installation 3-2.7
  Leakage tests 3-2.9.1
  Motor fuel systems 3-6.2.5
  Tank trucks and trailers 6-3.3.1
  Unloading line 3-3.3.4
Piping, valves & fittings . . . 2-4.2.1, 2-4.1
Pits to be avoided 3-3.4.6
Plans 1-5.1.1, 3-10.2.2
Plugged openings on containers other than DOT 2-2.3.3
Point of transfer 3-3.3, 4-3.2, 4-3.3
Portable containers *(see Skid tanks)*
  Transportation 6-2.2
Portable engines — Buildings 3-6.3.2
Portable space heating 3-4.1.1, 3-4.2.7, 3-4.5.2
Precautions or recharging required
  Consumer site 4-3.3.1
Pressure gauge connections . . . . 2-3.5.2, 2-2.3.5, 3-2.4.6(f)
Pressure gauges required 2-3.5
  Containers other than DOT . . . . 3-2.4.6(f), 2-2.3.4
  Tank trucks and trailers . . . . 6-3.2.1(f)
Pressure regulating equipment — Location 3-2.5.1, 2-5.8
  Motor fuel systems . . . . 3-6.2.4(c)
  Separation from vaporizer . . . 3-7.5.1(b)
Properties of LP-Gases . . . . 1-2.1.1, 1-1.1.1, Appendix A
Property line — Distance from containers to 3-2.2.2
Protection against collision
  Motor fuel container valves and connections . . . . 3-9.2.3(c)
Protection against corrosion — Piping 3-2.7.7
Protection against physical damage
  Cargo tanks 6-3.2.1
  Commercial vehicles . . . . 3-9.2.3(c)
  Motor fuel container valves and connections . . . . 3-6.2.6(c)
  Piping . . . . 3-2.7.6(d)
  Portable containers 2-2.4.2
  Relief valves, containers . . . . 3-2.4.3(f), 3-2.3.1(c)
  Tank accessories . . . . 3-2.4.6(b)
Protection against tampering
  Relief valves . . . . . . 2-3.2.4(d), 3-2.4.3(f)
  Tank accessories . . . . 3-2.4.6(b), (d)
Protection of container fittings 3-2.4.6(b)
Psia and psig, definition 1-7
Public buildings frequented by 3-4.1.1, 3-4.3.4
Public exhibitions or demonstrations 3-4.8
Pump discharge piping and recirculation device . . . . 3-2.10.1(b), 2-5.2.2, 4-2.3.3
Pump houses — Electrical equipment and open flames 3-8.2.1, 7-2.3.1
Pumps — Charging plants 3-2.10
Pumps — Service station . . . . 3-2.10.6(d), 3-2.10.1, 2-5.2.1
Pumps — Transfer 2-5.1, 2-5.2, 4-2.3.1, 4-2.3.3
Purging of containers 4-4.2

Q

- **Qualification of personnel** 1-6.1.1, 4-2.1
- **Quantity storage**
  - Industrial buildings 5-3.2.1
  - Outdoors 5-4.1.1
  - Public buildings 5-3.1.1
  - Special buildings 5-3.3.1
- **Quick closing valves**
  - Containers other than DOT 2-3.3.1
  - Tank trucks and trailers 6-3.2.1(b), (c), 2-3.3.1

R

- **Rain caps on relief valves**
  - Containers other than DOT 3-2.4.3(a)
  - Motor fuel containers 3-9.2.5(a)(4)
  - Tank trucks and trailers 3-2.4.3
- **Refrigerated storage** 1-2.3.1(a)
- **Regulating equipment** 3-2.5, 2-5.8
  - Commercial vehicles 3-5.2.2(a)
  - Cylinder systems 3-2.5.1
  - Motor fuel systems 3-6.2.2
  - Separation from vaporizers 3-7.5.1(b)
- **Regulators**
  - On cylinder systems 3-2.5.1
  - To be approved 1-3.1.1
- **Reinstallation of containers** 2-2.1.4
- **Relief devices** (*see also Relief valves*) 2-3.2, Appendix D
  - Containers other than DOT 2-3.2.4, 2-2.3.6, 2-3.2.3
  - Cylinder systems 3-2.4.4, 2-3.2.2
- **Relief valves**
  - General rules 2-3.2, Appendix D
  - Cargo tanks 3-2.4.3
  - Commercial vehicles 3-9.2.3, 3-9.2.5
  - In piping between shutoff valves 3-2.8.1, 2-4.7, 6-3.3.5
  - Motor fuel containers 3-6.2.6(i)
  - Orientation 3-2.3.1(b), 5-2.1.2
  - Testing Appendix D-2.5
  - To be approved 1-3.1.2
  - Vaporizer 2-5.4.2(d)
- **Repair — Cylinders** Appendix B-3.3
- **Requalification of cylinders** Appendix B
- **Research, industrial processing** 3-4.1.1, 3-4.5.1
- **Retroactivity** 1-2.4.1
- **Road clearance, systems on vehicles** 3-9.2.3(a)
- **Roadways for access** 3-10.2.6, 3-3.3.3
- **Roof, LPG on** 3-4.1, 3-4.9

S

- **Safety shutoff devices**
  - Agricultural heaters 2-6.3.1
- **Salamanders** 3-4.2.7
- **Scope** 1-2.1
- **Separation LPG**
  - Liquids 3-2.2.4
- **Setting of containers**
  - Cylinder systems 3-2.3.1
- **Sewer protection** 3-3.4.5, 3-2.10.6(h)
- **Shutoff valves**
  - Relief valve connections 2-3.2.4(c)
  - Required 3-2.4.6(a)
- **Sight flow indicators** 2-5.9
- **Skid tanks — Requirements for** 2-2.5.4, 2-2.5.5
- **Small containers** 3-4.8.3
- **Smoking prohibited at tank trucks** 6-3.10.1
- **Smoking — Service stations** 3-8.4.1(a), (b)
- **Spacing** 3-2.2.5, 3-2.2.2, 3-2.3.8(c), 4-1.2.3, 4-3.4.1, Table 3-2.2.2, Table 3-2.2.5(f)
- **Special protection** 3-10.3
- **Stacking of containers prohibited** 3-2.2.5(a)
- **Stamp — DOT on containers** 2-2.1.3, 2-2.6
- **Static protection** 3-8.1.3
- **Stationary engines in buildings** 3-6.3.1
- **Storage — Containers awaiting resale** 5-1.1
- **Storage in congested areas** 3-2.2.3
- **Storage — Industrial** 3-3.4.4
- **Storage in public buildings** 5-3.1.1
- **Storage rooms — Cylinders not in use** 5-2.1
- **Strainers** 2-5.5.1
- **Submittal of plans** 1-5.1.1, 3-10.2.2
- **Support of piping** 3-2.7.6
- **Support of systems on commercial vehicles** 3-9.2.3(b)
- **Support for containers other than DOT** 3-2.3.2, 2-2.5.2
- **Systems**
  - Approval of equipment 1-3.1.1
  - Definition 1-7
  - In industrial plants 3-3.3
  - Service limits 3-2.6

T

- **Tank accessories** 3-2.4.6
- **Tank car unloading** 3-3.3.3, 4-2.3.8, 4-2.3.6
- **Tank heaters** 3-7.4
- **Tank truck**
  - Differential regulator 6-3.4.5
  - Fuel system 6-1.1.3
  - Pumps and compressors 3-2.10, 6-3.4.1, 6-3.4.2
  - Unloading Chapter 4

- **Tank vehicle**
  - Garaging 6-6.2.1, 6-6.2.2
  - Parking 6-6.2.1
- **Tar kettles** 3-9.1.1, 3-9.2.4
- **Tests — Container** 2-2.1
- **Trailers and semitrailers**
  - Safety requirements 6-4.2
- **Training** 1-6.1.1
- **Transfer hose** 2-4.6
- **Transfer of liquid**
  - By hose 2-4.6
  - Operational safety 4-2
- **Transfer points** 3-3.3.1, 4-3.2, 4-3.3
- **Transport truck unloading**
  - Location 3-3.3.1, 4-3.3.2
- **Transportation, nonportable containers** 6-5.1
- **Transportation, portable containers** 6-2.2
- **Trucks**
  - Industrial 6-1.1.3
  - Fork lift 6-1.1.3
- **Truck cargo tanks, fuel from** 6-1.1.3
- **Truck exhaust** 6-3.9
- **Tubing**
  - General criteria 2-4.3
  - Motor fuel systems 3-6.2.3
  - Tank trucks and trailers 6-3.3

U

- **Underground container relief valves** 2-3.2.4(a), 3-2.4.3(d), (e)
- **Underground containers**
  - Installation 3-2.3.7
  - Markings 2-2.6.4(a)
  - Protection 3-2.3.8(c)
- **Unfired Pressure Vessel Code** 2-2.1
- **Unloading hose** 4-2.3.4, 2-4.6.1, 3-3.3.4, 6-3.3.4
- **Unloading tank cars or trucks** 3-3.3.3, 4-2.3
- **Used containers** 2-2.1.3(b), 2-2.1.4
- **Utility gas plants** 1-2.3.1(c)

V

- **Valves**
  - Approval of 1-3.1.1
  - Container shutoff 2-3.1.1
  - Cylinder system 3-2.4.6, 3-2.4.3
  - Emergency shutoff 2-4.5.3, 2-4.5.4, 6-3.2.1(d), 4-2.3.6, 3-3.3.4
  - Empty container 5-2.2.1
  - Excess flow (*see Excess flow valves*)
  - Internal 2-3.3.3(d), 2-3.3.1, 6-3.2.1(c)
  - Motor fuel containers 3-6.7.2
  - Shutoff 2-4.5, 3-2.10.6(d)(2), 3-2.4.3(g), 3-2.4.6(a)
  - Systems utilizing containers other than DOT 2-3.3.2, Table 2-3.4.2
  - Tank trucks and trailers 6-3.2.1
- **Valves on containers not connected** 5-2.2.1
- **Vapor indicators in pits** 3-3.4.6
- **Vapor meters** 2-5.6
- **Vapor pressure limit in containers** 4-2.2.4
- **Vaporizer burner** 3-7.5.1, 2-5.4.6
- **Vaporizers — General rules** 3-7.1
  - Electrical equipment 3-8.2.1
  - Motor fuel system 3-6.2.1
  - Safety devices for 2-5.4.1(e), 3-7.2.8, 3-6.5.4
- **Vehicle damage precautions** 3-6.2.6, 3-9.2.3
- **Vehicle garaging** 3-6.6
- **Vehicles fueled by LPG** 3-6
- **Ventilation** 7-2.2.1
  - Portable engines 3-6.3.1(c)
  - Storage rooms 5-3.3.3
  - Vaporizer heater rooms 2-5.4.3
- **Venting**
  - Cylinder storage rooms 5-3.3.3, 7-2.2.1, 7-2.1.1
  - Dispenser 3-2.10.6(e)
  - Regulators 3-2.5.4
  - Relief valves
    - Containers other than DOT 3-2.5.4, 3-2.4.3
    - Motor fuel containers 3-6.2.6(i)
    - Tank trucks and trailers 3-2.4.3
  - To atmosphere 4-4
- **Volume liquid permitted in container** 4-5.2.2

W

- **Walls, fire** 7-3.1.1
- **Watchman service** 3-3.6.1(a)
- **Water spray** 3-10.3.4, 3-10.3.5
- **Weeds near containers** 3-2.3.4(a), 3-2.2.5(b)
- **Welding, field, on containers** 3-2.3.1(e), 2-2.1.6

248 CMR 7.00: MASSACHUSETTS CODE FOR GAS UTILIZATION EQUIPMENT IN LARGE BOILERS

Section

7.01 General
7.02 Installation of Burners and Controls
Shutoff Valves
7.03 Initial Start-Up and Final Adjustments
7.04 Definitions

7.01: General

(1) Scope.

(a) This Code covers gas utilization equipment in commercial and industrial boilers having inputs over 400,000 BTU per hour per combustion chamber except: gas designed atmospheric multiple burner type boilers and water-tube boilers having outputs of 10,000 pounds of steam per hour (approximately 12,500,000 BTU per hour input) or more.*

(b) All gas-fired boilers, burners, and their accessories shall be approved. Approved shall mean acceptable to the Board of State Examiners of Plumbers and Gas Fitters.

In determining acceptability, the Board of State Examiners of Plumbers and Gas Fitters would normally base acceptance on compliance with the appropriate Boiler Code and this code. The Board of State Examiners of Plumbers and Gas Fitters may also refer to the listings or labeling practices of nationally recognized testing laboratories,** i.e., laboratories qualified and equipped to conduct the necessary tests, in a position to determine compliance with appropriate standards for the current production of listed items, and the satisfactory performance of such equipment or materials in actual usage; or the recommendations of a nationally recognized engineering agency specializing in the field of safety to life and property.***

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* See NFPA No. 85-1982 and NFPA No. 85B-1978 for Water-Tube Boilers having outputs of 10,000 pounds of steam or more.

(c) Before arranging for the selection or installation of a large gas burner or boiler, check with the serving gas supplier as to the availability of gas, specifying the gas input rating and the gas pressure required at the entrance to gas train. (See Figure 3 in 248 CMR 7.02)

(d) A written permit in a form and manner prescribed by the local gas inspector shall be obtained by persons performing gas fitting work as defined in Chapter 142 of the General Laws before commencing each installation.

(2) Combustion Air Supply and Ventilation.

(a) General.

1. Positive means for supplying an ample amount of outside air to permit combusion of the gas shall be provided. Automatic or manually adjustable control devices for outside air intake shall be interlocked with the burner.

** Among the Laboratories nationally recognized by the authorities having jurisdiction in the United States, are the Underwriters' Laboratories, Inc., the Factory Mutual Research Corporation, and the American Gas Association Laboratories.

*** Among the engineering agencies specializing in the field of safety to life and property nationally recognized by the authorities having jurisdiction are the Insured Risk Insurance Association, the Factory Mutual Research Corporation, and the National Board of Boiler and Pressure Vessel Inspectors.

2. To determine air requirements at the boiler, under standard atmospheric conditions (60°F and 30 inches mercury), the following minimum factors apply:

For boilers with draft hoods - 30 cubic feet per 1000 Btu input;

For boilers using barometric dampers - 15 cubic feet per 1000 Btu input; and

For boilers directly connected to a chimney without neutralizing air openings - 12 cubic feet per 1000 Btu input.

3. When a boiler is located in an inside room or space, air supply shall be provided through ducts or openings leading to the outside air.

4. Openings to the outside shall be unobstructed and screens, if used, shall have a minimum of 1/2 inch mesh.

5. When a room or space in which a boiler is installed is ventilated by mechanical means, air sufficient to replace that exhausted and consumed by combustion shall be supplied from a safe, uncontaminated source. The means for ventilation shall not create an unsafe pressure condition in the boiler room.

6. In addition to the combustion air required, sufficient air shall be supplied to the boiler room to make the room safe for occupancy and proper operation of equipment.

(b) Boilers Equipped with Draft Hoods. The effective cross-sectional area of the permanent outside air opening(s) to the boiler room shall be large enough to supply the air required in the boiler room. For supplying combustion air, the area of the opening shall be of a size at least equal to the boiler(s) breeching but not less than one square inch of free area per 5,000 Btu per hour input (approximately equal to 1.4 square feet per million Btu), except as noted in 248 CMR 7.01(2)(e).

(c) Boilers with Barometric Dampers. The effective cross-sectional area of the permanent outside air opening(s) to the boiler room shall be large enough to supply the air required in the boiler room for supplying air, the area of the opening shall be of a size at least equal to the boiler(s) breeching but not less than one square inch of free area per 14,000 Btu per hour input (approximately equal to 0.5 square foot per million Btu), except as noted in 248 CMR 7.01(2)(e).

(d) Boilers Directly Connected to Chimney Without Neutralizing Air Openings. The effective cross-sectional area of the permanent outside air opening(s) to the boiler room shall be large enough to supply the air required in the boiler room. For supplying air, the area of the opening shall be of a size at least equal to the boiler(s) breeching but not less than one square inch of free area per 17,500 Btu per hour input (approximately equal to 0.4 square foot per million Btu), except as noted in 248 CMR 7.01(2)(e).

(e) Exceptions.

1. Ducts to a Boiler Room: In determining the cross-sectional area of duct(s) used to convey air from the outdoors to the boiler room, the resistance to air flow imposed by the duct(s) shall be considered.

2. Forced Air Supply to Boiler Room: If mechanical means for boiler room air supply are used, the size of the duct or opening may be reduced to not less than that needed to provide the required quantity of air.

(3) Accessibility for Cleaning and Inspection. Sufficient and reasonable accessibility shall be afforded for inspection, cleaning, repair and replacement of all burners, combustion controls, safety devices and boiler components.

(4) Venting of Flue Gases.

(a) Chimneys.

1. All boilers shall be securely connected to a chimney in good condition and of proper construction and ample size to carry away the flue gases and

permit satisfactory burner operation under all weather and operating conditions.

2. The chimney shall be designed and built to take care of the maximum volume of flue gases which may be produced by the boilers connected to it, as well as any other combustion equipment, under the least conditions of draft which can be encountered. The design should also provide proper construction to resist wind forces, weathering, interior corrosion and flue gas temperatures.

3. The chimney shall be pre-inspected and, if necessary, tested to determine whether it is in suitable condition to handle the flue gases to be dispersed. Any defects shall be corrected.

4. An existing chimney shall be checked as to cross-sectional area, arrangement, and height to determine if it will handle the volume of flue gases produced by the boiler or boilers, under the least condition of draft that may be encountered. This shall include consideration of pressure and temperature conditions at which the flue gases enter the chimney and the effect of flue gases which may be fed into the chimney from other combustion equipment.

(b) Chimney Connectors.

1. Connectors from a boiler to its chimney shall be of noncombustible material capable of withstanding the corrosion effects and temperatures of the flue gases to be handled. They shall have sufficient strength to withstand the physical stresses likely to occur under the conditions of use and shall be securely supported.

2. The connector shall be installed so as to avoid excessive turns or other construction features which create unnecessary resistance to flow of flue gases.

3. The joint between the connector and the chimney shall be sealed to prevent gas leakage or air infiltration.

4. A connector shall not extend into a chimney beyond the inner wall of the chimney flue.

5. The connector shall be sized as recommended by the boiler or burner manufacturer. If the manufacturer's recommendations are not available, the connector shall be the size of the boiler flue collar, or if a draft hood is used, shall be the size of the outlet of the draft hood unless the connector is designed and installed in accordance with approved engineering methods.

6. On multiple installations, separate connectors should be run to the chimney. When this is not practical, each connector shall be Y-connected to a common breeching, the cross-sectional area of which shall be not less than the combined areas of the individual connectors.

(c) Draft Control.

1. Boilers requiring controlled chimney draft shall be provided with equipment capable of automatically regulating the draft to that recommended by the boiler manufacturer. Such control may be of the barometric type which regulates the draft in the boiler breeching or the mechanically operated damper type which controls the pressure in the boiler firebox or the draft hood type which is nonadjustable.

2. A double-acting barometric draft regulator, if used, shall be equipped with a device which will automatically shut off the fuel to the burner in the event flue gas spillage exceeds 60 seconds.

3. Mechanically operated dampers shall be designed to maintain a safe damper opening at all times and be arranged to prevent firing of the burner unless the damper is in the proper position.

4. When a draft control device is used, it shall be installed without alteration in accordance with the manufacturer's instructions. In no case shall a barometric draft control device be installed in a false ceiling, in a different room or in any place or manner that will permit a difference in pressure between a draft relief opening and the combustion air supply. A draft control device shall be installed in the position for which it was designed with reference to the horizontal and vertical planes and shall be located so that a relief opening is not obstructed. When induced or forced draft devices

are used, provision shall be made to prevent flow of gas to the burners upon failure of these devices.

5. Adjustable manual dampers should be removed except when a damper must be used to control excess chimney draft. Positive means shall then be provided to lock the damper in the proper position by welding or riveting. As an alternate, a portion of the damper can be removed to prevent full closure.

6. Full closing outlet isolation dampers shall be interlocked so that the boiler firing system cannot be operated unless its isolation damper is in the proper open position.

7. Adjustable (modulating) dampers, shall be arranged to maintain a safe fuel-air ratio over the full operating range. Linkage shall be arranged to resist accidental damage and disengagement. Any counter-balancing arms or weights attached to the damper shall be located or shielded as to prevent personal injury or damage to equipment in case of breakage.

8. When a draft hood is used, it shall be installed without alteration in accordance with the manufacturer's instructions. In no case shall a draft hood be installed in a false ceiling, in a different room, or in a manner that will permit a difference in pressure between the draft hood relief opening and the combustion air supply.

7.02: Installation of Burners and Controls

(1) Main Burners.

(a) Each burner assembly and its component parts shall be installed according to the manufacturer's instructions and shall be properly and firmly secured in place to maintain correct alignment in normal use.

(b) The burner assembly shall be installed so that sufficient accessibility is afforded for cleaning, inspection, repair, and replacement of all burners, controls and safety devices.

(c) Burner assembly parts, when adjustable, shall be provided with suitable locking devices to prevent accidental shifting.

(d) Provision shall be made to permit ready observation of each pilot and main burner flame during adjustment and under operating conditions.

(e) A burner assembly, when adjusted according to the manufacturer's instructions, shall maintain satisfactory operating characteristics as specified in 248 CMR 7.03(5) at all firing rates called for by input and air-gas ratio controls applied to the installation.

(2) Control Application.

(a) Each control shall be supported in such a manner that it and its sensing element will remain in proper position. It shall be possible to determine by observation or test that each control is in its proper location and capable of functioning as intended.

(b) Nothing shall be provided for the purpose of permitting any safety control to be rendered ineffective or allowing firing of the burner assembly without the protection of all of the specified safety controls except as permitted by 248 CMR 7.02(2)(c).

(c) A low-water cutoff may be bypassed for blow-down purposes only. Such a bypass shall be of a type which must be manually held in the bypass position and which is self-restoring when released.

(d) A burner assembly not equipped to provide safe automatic restarting shall be arranged to require manual restart after any control functions to cause the fuel supply to be shut off and the following restoration of an interrupted power supply.

(e) The safety-control circuit shall be two-wire, one side grounded, having a nominal voltage of 150 volts or less. The circuit shall be connected to a branch circuit that can be protected against overcurrent at not more than the value appropriate for the rating of the electrical components included in the circuit.

(f) A safety control or protective device switch shall interrupt the ungrounded conductor(s).

(g) Safety controls shall not depend on electricity to attain the off position.

(3) Control of Combustion Air.

(a) An air shutter shall be capable of being readily adjusted to any desired setting and securely locked to prevent accidental change in setting.

(b) The air inlet(s) shall supply an adequate amount of air for combustion under the specified draft conditions and at the maximum firing rate of the burner assembly as installed. All air required for combustion shall be introduced in a manner so as to provide thorough mixing of the gas and air. If a burner is intended for installation with an air or wind box(es), it shall be supplied by the burner manufacturer or be built in accordance with the burner manufacturer's instructions.

(c) Linkage for controlling air and gas input rates shall be designed to reliably maintain the correct gas-air ratio and to resist accidental damage and disengagement.

(d) Boilers having forced or induced draft fans or both, shall be provided with means to automatically continue safe combustion or to shut off the gas supply upon failure of the equipment supplying the air.

(e) If air under pressure is mixed with the gas supply in a mixer, effective means shall be provided to prevent air from passing back into the gas line, or gas into the air supply. The gas and air supply shall be controlled to prevent gas from entering burners until the air supply is available and, in the event of air failure, to shut off the gas supply.

(4) Primary Safety Control (Flame Safeguard).

(a) Each burner assembly shall be provided with a non-recycling primary safety control that will de-energize the main gas safety shutoff valve(s) upon loss of flame at point of supervision.

(b) Safety control timings shall not exceed the values given in Table 1 in 248 CMR 7.02.

(c) Gas to pilots shall be automatically shut off if the pilot is not proved, and safety shutdown established.

(d) Pilot supervision by the primary safety control shall be only at the point where the pilot flame will effectively ignite the gas at the main burner or burner group with the pilot burning at any flame that will actuate the safety control.

(e) Supervision of the main burner flame only shall begin at the end of the main burner flame-establishing period for:

1. Power burners having a firing rate per combustion chamber of 2,500,000 Btu per hour and over.

TABLE 1.

Maximum Safety Control Timings

	Maximum Firing Rate Per Combustion Chamber in Million Btu Per Hour		
	2.5 or less	over 2.5 to 12.5	over 12.5
Pilot flame-establishing period	15 sec.	10 sec.	10 sec.
Main burner flame-establishing period (if required)	15 sec.*	10 sec.*	10 sec.*
Flame failure response time	4 sec.	4 sec.	4 sec.
Valve closing time	5 sec.	1 sec.	1 sec.

*Main burner flame-establishing period may be 30 seconds for burner other than power burners equipped with a safety shutoff valve having a full opening time of not less than 25 seconds.

2. all types of burners with modulating or high-low firing rate per combustion chamber of 2,500,000 Btu per hour and over,

3. all types of burners with an interrupted pilot(s), and

4. atmospheric type burners having a firing rate per combustion chamber of 5,000,000 Btu per hour and over.

If the main burner flame is not proved, safety shutdown shall be established.

(f) A burner assembly shall be equipped so that no gas can flow to the main burner or burner group operating as a unit unless the pilot is proved.

(g) If two or more burner assemblies are installed in a single boiler, the primary safety control of each burner assembly shall operate independently of the other, or equivalent safety features shall be provided so that in no case can any one burner operate unsafely.

(5) Limit Controls.

(a) A limit control shall be provided to prevent excessive steam pressure in a steam boiler or excessive pressure or temperature in a hot water boiler. Also, each steam and hot water boiler shall be equipped with a control which will prevent firing of the boiler in the event of insufficient water in the boiler. The limit control shall be in addition to operating controls. Manual restart shall be required after a pressure or temperature limit control functions.

(b) A limit control which functions by opening a switch shall directly open the electrical circuit to the safety shutoff valve(s).

(6) Combustion (input) Control Systems.

(a) The combustion (input) control system shall maintain predetermined air-fuel mixtures within the limits required by the burner for stable combustion throughout the entire operating range of the burner and during changes in the firing rate.

(b) To accomplish changes in the firing rate, the fuel and air supplies shall be maintained at a predetermined optimum air-fuel ratio, either manually or automatically.

(c) Burners having a firing rate per combustion chamber of 1,000,000 Btu per hour and over shall be equipped with a proven low-fire start.

(d) Burners having a firing rate per combustion chamber of 2,500,000 Btu per hour and over shall be provided with combustion control.

(7) Pilots.

(a) Main burners shall be equipped with a supervised pilot adequate to provide safe main burner ignition under all conditions of operation. Multiple burner heads operated as a single burner unit shall use a sufficient number of supervised pilots to accomplish safe ignition.

(b) A pilot burner not automatically lighted shall be located so that it can be safely lighted manually.

(c) The gas supply pressure to the pilot or group of pilots shall be regulated. The regulator(s) shall be listed; and vented in accordance with the 248 CMR 7.02(11)(c), unless constructed or equipped to limit the escape of gas from the vent opening in the event of diaphragm failure to not more than 1.0 cubic foot per hour. The pilot supply line shall be connected upstream of all main burner valves and the main gas pressure regulator.

(d) Primary air openings and orifices shall be easily accessible for servicing.

(e) An electric ignition system shall ignite only a pilot.

(f) If means for ignition is cut off at the termination of either the main burner flame-establishing period or the pilot flame-establishing period, the ignition shall remain off for the duration of that firing cycle and for the specified purge period.

(g) A pilot burner, electric igniter, and pilot flame sensing device shall be supported in such a manner that their position relative to each other and to the main burner port(s) will remain fixed.

(8) Gas Valve Pressure Ratings. Gas valves shall be capable of withstanding without damage a pressure of not less than 10 percent above the relieving pressure of the nearest upstream relief device. In case no relief device is provided, the gas valves shall be capable of withstanding without damage a pressure of not less than the maximum inlet pressure of the nearest upstream gas pressure regulator or the maximum setting of the over-pressure protection device.

(9) Manually Operated Gas Shutoff Valves (See Figures 1 and 2 in 248 CMR 7.02).

(a) A manually operated main burner shutoff valve shall be installed in the line supplying all main burners of each boiler and upstream of all other main burner control valves.

(b) A manually operated main pilot shutoff valve shall be located in the gas supply line to the pilot burner.

(c) Manually operated main shutoff and pilot shutoff valves in sizes larger than 2 inches or for pressures greater than 1/2 psig shall be of the lubricated plug or ball type with stops. Manually operated valves shall have the handle securely attached parallel to the gas flow in the open position, shall be readily accessible, and shall clearly indicated the "on" and "off" positions.

(d) A manually operated main burner test valve (checking gas cock) shall be provided downstream from the safety shutoff valve for each main burner. On manually lighted burners, the valves shall be interlocked with the safety control circuit and arranged so that the main burner safety shutoff valves must be opened against their associated closed test valves.

(e) In multiple burner installations a manual valve shall be provided for each main and each pilot burner except those utilizing a single zero governor inspirator mixer for several burners in which case this valve shall be located at a point immediately upstream of the zero governor.

(f) Provisions shall be made so that the gas supply to the boiler(s) may be shut off from a location outside the boiler room.

(10) Control and Safety Shutoff Valves (See Figure 3 in 248 CMR 7.02).

(a) An automatic boiler input control valve may be in combination with a safety shutoff valve.

(b) A bypass to provide for minimum flame may be installed around a valve to control boiler input only. A bypass shall not be installed around a safety shutoff valve or a combustion input control and safety shutoff valve.

(c) Each main burner supply line and each pilot supply line shall be equipped with a safety shutoff valve(s) which will close independent of external force. The safety shutoff valve(s) shall close with sufficient force to provide tight shutoff under normal operating conditions and when closed by the safety control system or by an emergency device. If the maximum firing rate per combustion chamber exceeds 1,000,000 Btu per hour, the main burner supply line shall be equipped with two safety shutoff valves in series. The Board of State Examiners of Plumbers and Gas Fitters may prescribe two safety shutoff valves in series, for combustion chambers with inputs less than 1,000,000 Btu per hour, in buildings of public assembly.

(d) Safety shutoff valves shall be suitable for the application and shall have a shutoff time not to exceed that specified in Table 1 in 248 CMR 7.02. They shall be constructed so that they cannot be restrained or blocked in the open position. Such valves shall close upon being de-energized regardless of the positions of damper-operating levers or reset handles.

(e) An electrically operated safety shutoff valve shall not depend on electricity to shut off the gas supply.

(f) A pressure-operated safety shutoff valve shall close upon failure of its operating pressure.

(g) Permanent and ready means for making easy, accurate, periodic tightness tests of the main burner gas safety shutoff valves shall be provided in the piping.

(11) Main Gas Pressure Regulators and Gas Pressure Interlocks.

(a) Each burner assembly shall be equipped with a listed main gas pressure regulator that will regulate within plus or minus 10 percent of the operating pressure at all firing rates. (See Figure 3 in 248 CMR 7.02 for location).

(b) Spring or weight-loaded regulators shall have springs covered by a suitable housing. Under no circumstances shall a weight and lever type of regulator be used.

(c) Except where zero governors are used in connection with air-gas mixers, all main gas pressure regulators shall be independently vented to a safe outdoor location. Vent lines from regulators shall not be connected into a common line with the bleed line from gas operated diaphragm valves or from pressure relief valves. Vent lines shall be of steel or wrought iron pipe with means provided at termination points to prevent stoppage of the lines by foreign material, water or insects. Vent lines shall be sized as specified in Table 2 in 248 CMR 7.02.

(d) If the maximum firing rate per combustion chamber exceeds 1,000,000 Btu per hour, gas pressure supervision shall be provided by listed pressure switches interlocked to accomplish a non-recycling safety shutdown in the event of either high or low gas pressure. Pressure setting shall be adjusted by the installer in accordance with the burner or boiler manufacturers' instructions. Pressure switches that require venting to the outside atmosphere shall be vented in accordance with 248 CMR 7.02(11)(c).

(e) Accessible one-fourth inch IPS plugged pressure tappings or connections shall be provided; one located upstream of the main gas pressure regulator and another located near the burner head to permit accurate measurement of gas pressure. (See Figure 3 in 248 CMR 7.02).

TABLE 2

Minimum Pipe Size for Venting
Gas Train Components in Figure 3
in 248 CMR 7.02.

	0 - 40 Feet	0 - 100 Feet	0 - 200 Feet
Main Gas Pressure Regulator	3/4" IPS	1" IPS	1 1/4" IPS
High & Low Gas Pressure Switches Manifolded	3/4" IPS	1" IPS	1 1/4" IPS
Bleed Valves (when used)	Full IPS Relief	Increase IPS 1 Size	Increase IPS 2 Sizes

(12) Electrical Equipment. Electrical installations shall conform to the National Electrical Code, NFPA 70-1981.

(13) Operating Sequencing. (Also see 248 CMR 7.03, Initial Start-Up and Final Adjustments).

Each installation shall be equipped to provide for sequencing in accordance with the following and in the order listed.

(a) Natural and mechanical draft systems with continuously burning pilot(s) capable of igniting any gas flowing from the main burner shall, upon demand for heat:

1. Prove all interlocks.
2. Prove combustion air flow for mechanical draft systems.
3. Prove in light-off position, if either an automatically operated damper, an automatically operated air shutter, or both, are employed.
4. Prove combustion (input) control, if employed, in light-off position.
5. Prove pilot(s).
6. Admit fuel to main burner.
7. Prove main flame, if required, in accordance with 248 CMR 7.02(4)(e).
8. Release combustion (input) control.
9. Upon flame failure at point of supervision, shut off fuel by primary safety control.
10. Shut off fuel to main burner on release from demand.

(b) Natural draft systems with intermittent pilot or interrupted pilot shall, upon demand for heat:

1. Prove all interlocks.
2. Prove open for at least 90 seconds if either an automatically operated damper, an automatically operated air shutter, or both, are employed.
3. Prove in the light-off position if either an automatically operated damper, and automatically operated air shutter, or both are employed.
4. Prove combustion (input) control, if employed, in light-off position.
5. Prove pilot(s).
6. Admit fuel to main burner.
7. Prove main flame, if required, in accordance with 248 CMR 7.02(4)(e).
8. Release combustion (input) control.
9. Upon flame failure at point of supervision, shut off fuel by primary safety control.
10. Shut off fuel on release from demand.
11. If an automatically operated damper is employed, return to stand-by position.

(c) Mechanical draft systems with intermittent pilot or interrupted pilot shall, on demand:

1. Prove all interlocks.
2. If an automatically operated damper is employed, prove in open position.
3. Start fan(s) and prove air flow. Provide at least a four-air change purge of the combustion chamber and boiler passes. The four air changes must be accomplished in not more than 90 seconds with burners having maximum firing rate per combustion chamber of not more than 2,500,000 Btu per hour. With burners having maximum firing rates per combustion chamber in excess of 2,500,000 Btu per hour, the four air changes shall be accomplished without time limitation by an air flow rate not less than 60 percent of the air flow provided for the maximum firing rate.
4. Prove combustion (input) control and automatically operated damper, if employed, in light-off position.
5. Prove pilot(s).
6. Admit fuel to main burner.
7. Prove main flame, if required, in accordance with 248 CMR 7.02(4)(e).
8. Release combustion (input) control.
9. Upon flame failure at point of supervision, shut off fuel by primary safety control.
10. Shut off fuel on release from demand.
11. If an automatically operated damper is employed, return to stand-by position.

7.03: Initial Start-Up and Final Adjustments

(1) Authorized Representative. An authorized representative of the boiler or burner manufacturer shall perform the initial start-up, final adjusting and testing of the burner and controls in the presence of the gas inspector and gas company representative.

(2) Purging Boiler. The furnace, passes, and connected flue piping shall be thoroughly purged before lighting of pilots or burners. This shall be done by creating air flow through the setting by fully opening flue dampers and air shutters and by operation of induced and forced draft fans, if present.

(3) Control Operating Tests.

(a) All controls shall be thoroughly checked for proper operation and sequencing before the burner is put into operation. Manufacturer's instructions shall be followed.

(b) All safety shutoff gas valves shall be tested for gastightness while in the closed position before being placed in service. During this test, gas shall be shut off to all burners downstream from the safety shutoff gas valve.

(4) Pilot Operation Tests.

(a) After the gas piping has been thoroughly cleared of air and any foreign materials, the pilot burner shall be lighted and adjusted with the main burner manual and automatic valves in the closed position. Adjustment to the pilot shall be made in accordance with manufacturer's instructions.

(b) Pilots shall not deposit carbon when adjusted according to the manufacturer's instructions.

(c) When escapement or bleed pilots are used, the discharge shall be in a fixed position and shall be freely ignited by the continuous burning pilot or vented to a safe location.

(5) Burner Operation Tests.

(a) The main burner shall be put into operation and tested only after 248 CMR 7.03(2), 7.03(3) and 7.03(4) have been completed. Manufacturer's instructions shall be followed for light-off and adjustment of the main burner.

(b) Pilots shall reliably effect immediate ignition of the main burner even when the gas supply to the pilot(s) is reduced to a point where the pilot flame is just sufficient to actuate or energize the flame detection device. Follow the manufacturer's instructions in conducting this test.

(c) Continuously burning pilot flames shall not become extinguished: when the main burners are turned on or off in a normal manner, either manually or by automatic controls, when the air flow through the burner is rapidly changed from maximum to minimum or vice versa after the main burners are shut off following operation of boiler at its maximum capacity, nor during any normal operating conditions that will occur.

The above tests shall be repeated three times.

(d) The pilot burner shall reliably ignite the main burner under any normal condition of operation.

(e) The arrangement of burners, valves, and pilots shall be such that when only the pilots supervised by the flame safeguard equipment are in operation, any burner or combination of burners shall be effectively ignited without delayed ignition or flash back.

(f) Burner flames shall not flash back when fired at any rate within the installed operating range of the burner.

(g) Burner flames shall not flash outside the boiler when the gas is turned on or off by the automatic control mechanism.

(h) Proper air-gas ratio shall be maintained and combustion shall be complete over the full installed operating range of the burner.

(6) Test for Venting. A check shall be made for proper venting with the burner operating at maximum installed input and with all building exhaust fans operating which are in communication with the boiler room and with all outside closeable boiler room openings shut.

(7) Instructions to the Operator.

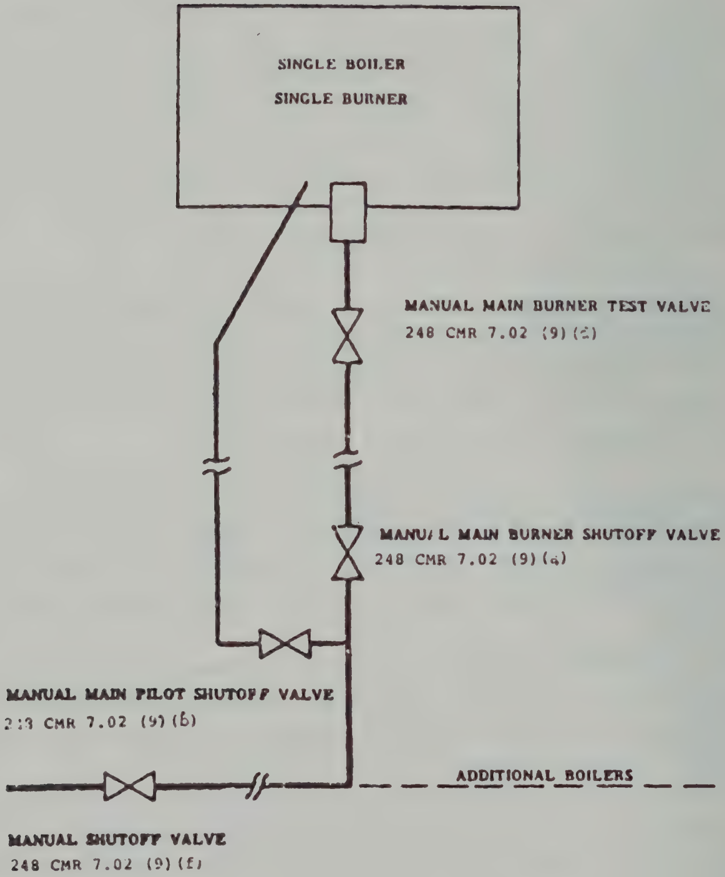
(a) Complete written or printed instructions including wiring diagrams shall be supplied and made conveniently available or posted in a permanent form in a prominent place near the boiler. These instructions shall include complete start up as well as normal and emergency shutdown procedures. Start up shall be from the methods provided by the control system for that purpose.

(b) To guard against malfunctioning all controls should periodically be tested on a scheduled basis.

(c) Extended Shutdown. When a boiler is shut down for an extended period it is recommended that in addition to closing all gas valves, as a further precaution, gas be prevented from leaking into the boiler by blocking off or disconnecting and capping or plugging the gas supply pipe.

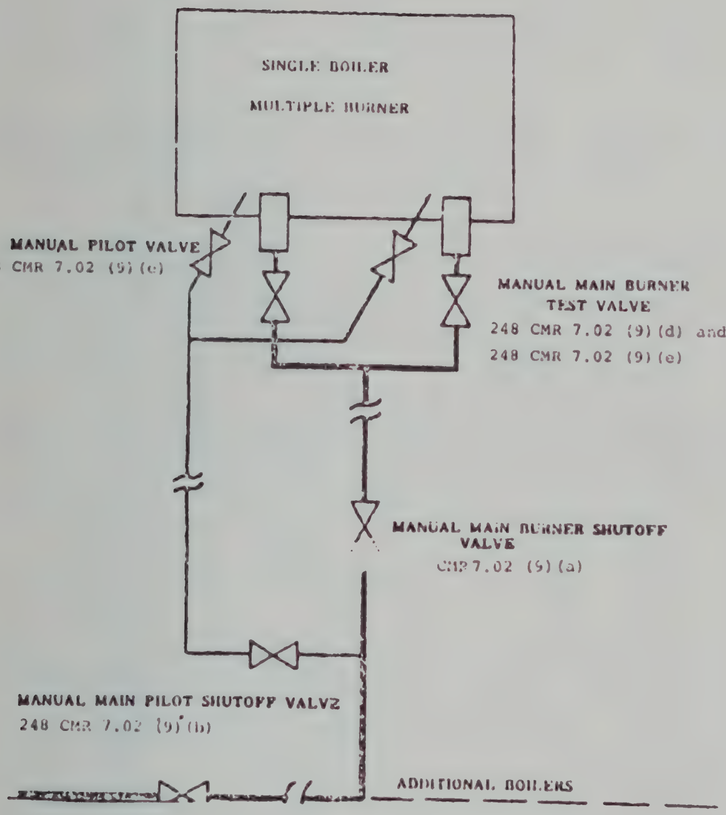
7.02: continued

FIGURE 1. Manual Valving Arrangement for a Single Burner — Single Boiler Installation



7.02: continued

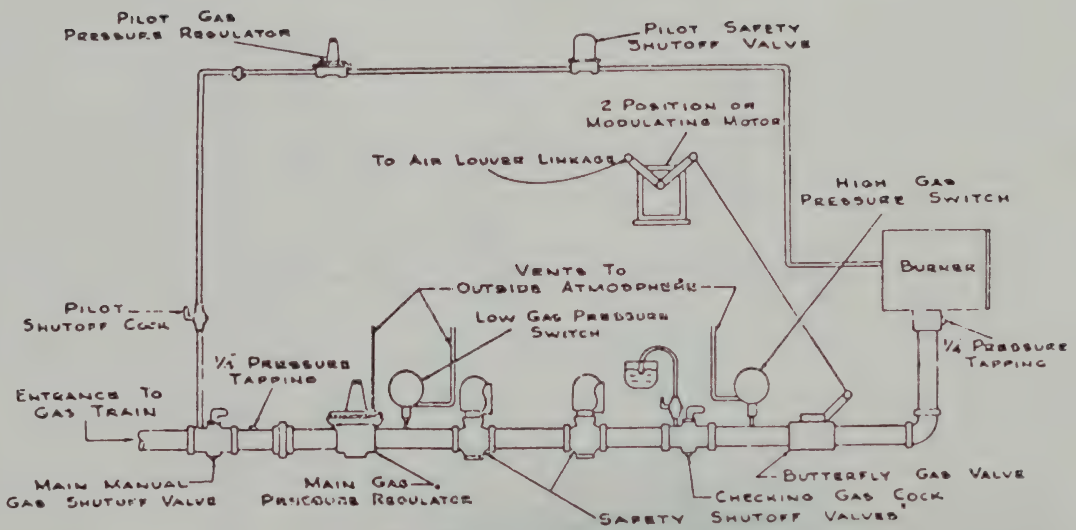
FIGURE 2. Manual Valving Arrangement for a Multiple Burner — Single Boiler Installation



7.02: continued

FIGURE 3. Gas Manifold System

FIGURE 3. GAS MANIFOLD SYSTEM



Note: Since the maximum firing rate per combustion chamber may allow for modification of this manifold system, refer to the specific requirements listed in the text.

7.04: Definitions

Air Shutter. An adjustable device for varying the size of the air inlet or inlets regulating primary or secondary air.

Air Shutter, Automatically Operated. An air shutter operated by an automatic control.

Approved. The word "approved" as used in this standard means acceptable to the administrative authority enforcing this standard. (See 248 CMR 7.01(1)(c).

Authority Having Jurisdiction. The organization, office or individual responsible for "approving" equipment, an installation, or a procedure.

Boiler, High-Pressure. A boiler furnishing steam at pressure in excess of 15 psi or hot water at temperatures in excess of 250°F or at pressures in excess of 160 psi.

Boiler, Low-Pressure Hot Water and Low-Pressure Steam. A boiler furnishing hot water at pressures not exceeding 160 psi and at temperatures not more than 250°F or steam at pressures not more than 15 psi.

Breeching. (See Chimney Connector.)

Burner. A device for the final conveyance of the gas, or a mixture of gas and air, to the combustion zone.
- (a) Injection (Bunsen) Type Burner. A burner employing the energy of a jet of gas to inject air for combustion into the burner and mix it with the gas.
- (b) Atmospheric Injection Type Burner. A burner in which the air at atmospheric pressure is injected into the burner by a jet of gas.
- (c) Luminous or Yellow Flame Burner. A burner in which secondary air only is depended on for combustion of the gas.
- (d) Power Burner. A burner in which either gas or air or both are supplied at pressures exceeding, for gas, the line pressure, and, for air, atmospheric pressure; this added pressure being applied at the

burner. A burner for which air for combustion is supplied by a fan ahead of the appliance is commonly designated as a forced draft burner.

(e) Premixing Burner. A power burner in which all or nearly all of the air for combustion is mixed with the gas as primary air.

(f) Induced Draft Burner. A burner which depends on the draft induced by a fan beyond the appliance for its proper operation.

(g) Pressure Burner. A burner which is supplied with an air-gas mixture under pressure (usually from 0.5 to 14.0 inches of water and occasionally higher).

Burner Head. That portion of a burner beyond the outlet end of the mixer tube which contains the ports.

Burner, Automatically Lighted. One where fuel to the main burner is normally turned on and ignited automatically.

Burner, Manually Lighted. One where fuel to the main burner is turned on only by hand and ignited under supervision.

Chimney. A vertical shaft enclosing one or more flues for conveying flue gases to the outside atmosphere.

(a) Factory-Built Chimney. A listed chimney.

(b) Masonry Chimney. A chimney of solid masonry units, bricks, stones, listed masonry chimney units or reinforced concrete, lined with suitable flue liners.

(c) Metal Chimney. A field-constructed chimney of metal.

Chimney Connector. The pipe which connects a fuel-burning appliance to a chimney.

Combustion. Combustion, as used herein, refers to the rapid oxidation of fuel gases accompanied by the production of heat or heat and light.

Combustion Control. A control which automatically regulates the firing rate at predetermined air-fuel ratios in accordance with load demand.

(a) High-Low Firing. The action of a combustion control which positions the air and fuel supply for low-fire and for high-fire in accordance with load demand.
(b) Modulating. The action of a combustion control which gradually varies the air and fuel supplies within limits in accordance with load demand.

Combustion (Input) Control Valve. An automatic gas-control valve for regulating boiler input.

Combustion Products. Constituents resulting from the combustion of a fuel gas with the oxygen of the air, including the inerts, but excluding excess air.

Condensate. The liquid which separates from a gas (including flue gases) due to a reduction in temperature.

Controls. Devices designed to regulate the gas, air, water or electrical supply to a boiler. These may be manual, semi-manual, semi-automatic or automatic.

Control,Limit. An automatic control responsive to changes in liquid level; in fuel, steam or air pressure; in air, gas or liquid flow; or in temperature; for limiting the operation of the controlled equipment.

Control, Primary Safety. A control responsive directly to flame properties; sensing the presence of flame and causing fuel to be shut off in the event of ignition or flame failure requiring manual reset.

Control,Safety. Automatic controls and interlocks (including relays, switches, and other auxiliary equipment used in conjunction therewith to form a safety control system which are intended to prevent unsafe operation of the controlled equipment.

Damper. A valve or plate for controlling draft or flow of the flue gases. A damper is generally considered as being located on the downstream side of the combustion chamber usually in a flue passage of the appliance or in the chimney or vent connector.

Damper, Automatically Operated. A damper operated by an automatic control.

Damper, Manually Operated. An adjustable damper manually set and locked in the desired position.

Draft Regulator, Barometric. A device which functions to maintain a desired draft in the appliance by automatically reducing the chimney draft to the desired value.

Flame Safeguard. (See Control, Primary Safety.)

Flue Gases. Products of combustion and excess air.

Interlock. A device to prove the physical state of a required condition, and to furnish that proof to the primary safety control circuit.

Labeled. Equipment or materials to which has been attached a label of a nationally recognized testing laboratory that maintains periodic inspection of production of labeled equipment or materials and by whose labeling is indicated compliance with nationally recognized standards or has been tested and found safe for use in a specified manner.

Listed. Equipment or materials included in a list published by a nationally recognized testing laboratory that maintains periodic inspections of production of listed equipment or materials and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found safe for use in a specified manner.

Low-Fire Start, Proven. The firing of a burner with fuel and combustion air controls interlocked in a low-fire position to provide safe operating conditions during light off.

Lubricated Plug-Type Valve. A valve of the plug-and-barrel type designed for maintaining a lubricant between the bearing surfaces.

Main Burner Flame-Establishing Period. The length of time the main burner fuel safety shutoff valves are permitted to be open before the flame sensing device is required to supervise the main burner flame.

Optimum Air-Fuel Ratio. A ratio of air to fuel going to the furnace which will provide complete combustion of the fuel with sufficient range of excess air to maintain a stable flame envelope.

Pilot. A flame which is utilized to ignite the gas at the main burner or burners.

Pilot, Continuous. A pilot that burns without turndown throughout the entire time the burner is in service, whether the main burner is firing or not.

Pilot, Expanding. A continuously burning pilot that is automatically expanded so as to reliably ignite the main burner. This pilot may be turned down at the end of the main burner flame-establishing period.

Pilot Flame-Establishing Period. The length of time fuel is permitted to be delivered to a proved pilot before the flame sensing device is required to detect pilot flame.

Pilot, Intermittent. A pilot which is automatically lighted each time there is a call for heat. It burns during the entire period that the main burner is firing.

Pilot, Interrupted. A pilot which is automatically lighted each time there is a call for heat. The pilot fuel is cut off automatically at the end of the main burner flame-establishing period.

Pilot, Proved. A pilot flame supervised by a primary safety control.

Purge. To introduce air into the combustion chamber and boiler passes in such volume and manner as to completely replace the air or gas-air mixture contained therein.

Regulator, Gas Pressure. An automatic gas pressure reducing device for the purpose of maintaining a uniform gas supply pressure.

Safety Shutdown. The action of shutting off all fuel and ignition energy to the appliance by means of a safety control or controls such that restart cannot be accomplished without manual reset.

Safety Shutoff Valve. A gas-control valve that is automatically closed by the safety control system or by an emergency device. The valve may be of the automatically or manually opened type.

Throttling. (See "Modulating" under Combustion Control).

Trial-For-Ignition Period. (See Main Burner Flame-Establishing Period.)

Zero Governor. A regulating device which is normally adjusted to deliver gas at atmospheric pressure within its flow rating.

REGULATORY AUTHORITY

248 CMR 7.00: M.G.L. c. 142, s.13.

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